WATER WITHDRAWAL PERMIT APPLICATION

Required under Part 327 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Failure to follow the provisions of the act may result in a civil fine up to $1,000.

EGLE
MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

I. Applicant Information		Primary Contact Information (if applicable)	
Property or Facility Name Jackson Generating Station		Name Rachel Proctor	
Project Name (if applicable)		Company Consumers Energy Company	
Property Owner or Representative Name Rachel Proctor, Consumers Energy Company		Mailing address, City, State, Zip code 1945 W. Parnall Rd., Jackson, MI 49201	
Mailing address, City, State, Zip code 1945 W. Parnall Rd., Jackson, MI 49201		Phone	Email n
Phone	Email	**Authorization from Property Owner or their Representative**	
		Attach written authorization to act as the primary contact for the permit.	

II. Proposed Water Withdrawal Information (see instructions)

a. Water Source and Pump Information

1. Name of Water Source (and description of project boundary, if applicable)	2. Water Source Type (choose one)	3. Total Maximum Pump Capacity	4. Location (approximate centroid, if applicable)
Groundwater; See Figure 1	☑ Groundwater ☐ Inland Surface Water ☐ Great Lakes or Connecting Waterways	7.5 MGD; 3 pumps at 2.5 MGD each Million Gallons per Day	Latitude: 42.248958 Longitude: -84.374669

b. Maximum Withdrawal per Month in MILLIONS OF GALLONS

January	February	March	April	May	June
62	58	77.5	75	91	105
July	**August**	**September**	**October**	**November**	**December**
108.5	124	90	77.5	75	62

c. Primary Purpose of Use

Description: Supply water for use in evaporative cooling towers and the power generation units. The withdrawal will not be used for the potable needs at the facility.

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III. Proposed Return Flow Discharge Information

a. Name of Discharge Location	b. Receiving Water Type (choose one)	c. Location	d. Total Discharge Volume or Rate
Permitted discharge to City of Jackson sanitary sewer north of the JGS, near the corner of Chapin and South Forbes Streets	☐ Groundwater ☑ Inland Surface Water ☐ Great Lakes or Connecting Waterways	Latitude: 42.248958 Longitude: -84.374669	0.256 ☑ Millions of Gallons Per Day, or ☐ Percentage of Proposed Withdrawal

IV. Evaluation of Existing Hydrological and Hydrogeological Conditions

Attach documentation of existing hydrological and hydrogeological conditions including an evaluation of the potential effects of the proposed withdrawal on neighboring water wells, wetlands, and inland lakes or streams.

V. Private Property Conflict Contingency Plan

Attach documentation of a contingency plan for corrective actions in the event of conflict with the normal operation of neighboring water wells, including temporary or permanent impact to the quantity and/or quality of water previously furnished by neighboring wells, or other conflicts with private property rights.

VI. Environmentally Sound and Economically Feasible Water Conservation Measures

Attach documentation identifying the water conservation measures applicable to your water use sector or to your specific withdrawal. Provide self-certification that you will be in compliance with the water conservation measures. Water conservation measures are available online at http://www.michigan.gov/wateruse .

VII. Decision-Making Standard of the Great Lakes – St. Lawrence River Basin Water Resources Compact

Attach documentation describing how the withdrawal will be implemented such that all of the following criteria are met:

1. All water withdrawn shall be returned, either naturally or after use, to the source watershed less an allowance for consumptive use;
2. The withdrawal will be implemented so as to ensure it will not result in significant individual or cumulative adverse impacts to the quantity or quality of the waters and water dependent natural resources of the source watershed and the Great Lakes;
3. The withdrawal will be implemented so as to incorporate Environmentally Sound and Economically Feasible Water Conservation Measures;
4. The withdrawal or consumptive use will be implemented so as to ensure that it is in compliance with all applicable municipal, State and federal laws as well as regional interstate and international agreements, including the Boundary Waters Treaty of 1909;
5. The proposed use is reasonable under common law principles of water law in Michigan, based upon a consideration of the following factors:
   a) Whether the proposed withdrawal is planned in a fashion that provides for efficient use of the water, and will avoid or minimize the waste of water;
   b) If the proposal is for an increased withdrawal, whether efficient use is made of existing water supplies;
   c) The balance between economic development, social development and environmental protection of the proposed withdrawal and use and other existing or planned withdrawals and water uses sharing the water source;
   d) The supply potential of the water source, considering quantity, quality, and reliability and safe yield of hydrologically interconnected water sources;
   e) The probable degree and duration of any adverse resource impacts caused or expected to be caused by the proposed withdrawal under foreseeable conditions, to other lawful consumptive or non-consumptive uses of water or to the quantity or quality of the waters and water dependent natural resources of the Basin, and the proposed plans and arrangements for avoidance or mitigation of such impacts; and,
   f) Consideration as to the need for the proposal to include restoration of hydrologic conditions and functions of the source watershed.

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MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

VIII. Does this facility hold a permit issued under Part 31 for a cooling water intake structure?			
☐ YES	Please attach a copy of the signed Part 31 discharge authorization, certificate of coverage, or other substantiating documentation.	☑ NO	

IX. Permit Application Return and Payment	
I understand that my signature constitutes a legal agreement as to the accuracy and truthfulness of the information provided in this application. Further, I certify as to compliance with the Water Use Conservation Measures identified in Section VI of the permit application.	When completed, mail this form and a $2,000.00 permit application fee to the address below. Please make your check payable to STATE OF MICHIGAN (do not send cash).
X [signature] 1/21/2022	**RETURN TO:** MICHIGAN DEPT. OF ENVIRONMENT, GREAT LAKES, AND ENERGY CASHIER'S OFFICE – WURF PO BOX 30657 LANSING, MI 48909-8157
Property owner or representative's signature Date	

FOR EGLE CASHIER'S OFFICE USE ONLY: 60000-42248-9175

EGLE

Part 327 Water Withdrawal Permit Application for the Jackson Generating Station

Jackson, Michigan

Submitted to:

Mr. Andy LeBaron
MI EGLE Water Use Division

Submitted by:

Golder Associates USA Inc.
15851 South US 27, Suite 50
Lansing, Michigan, USA 48906

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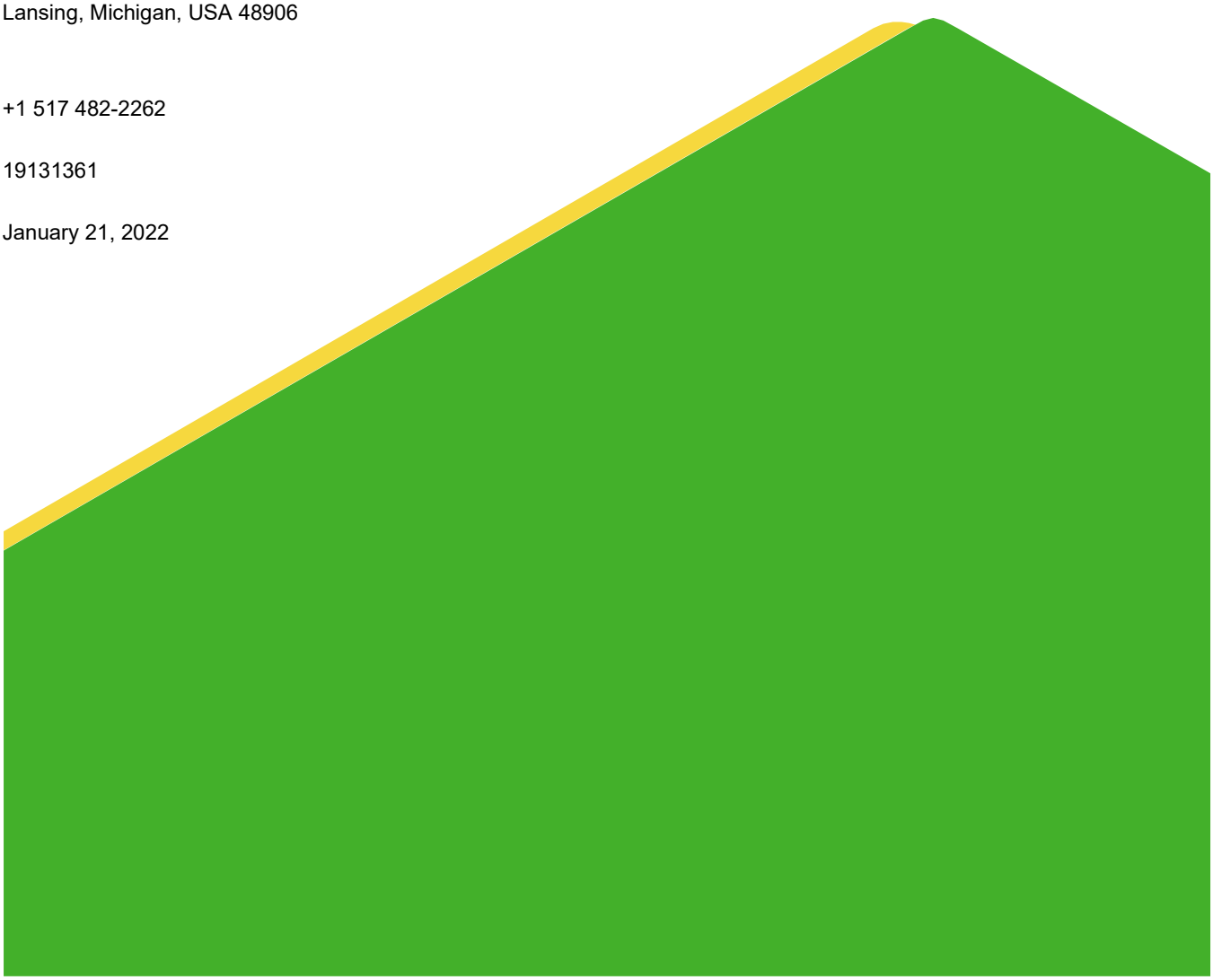
19131361

January 21, 2022



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Executive Summary

Consumers Energy Company (CEC) requests that the Michigan Department of Environment, Great Lakes, and Energy (EGLE) grant approval pursuant to Part 327 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, to withdraw greater than 2 million gallons per day (MGD) of groundwater at the natural gas Jackson Generating Station (JGS) in Jackson, Michigan. The groundwater will be used for various processes related to electric generation at JGS, particularly evaporative cooling. As described in the CEC 2021 Clean Energy Plan, CECs generation portfolio continues to shift from coal-fired baseload generation to alternative generation including solar, wind, and natural gas. CEC therefore anticipates increased use of the JGS generators to meet increasing local and statewide energy demands as coal-fired facilities are retired.

The original 2002 development agreement between Kinder Morgan and the City of Jackson specified that municipal water would be purchased for 10 years from the start of operations, after which Kinder Morgan had the option of developing an alternate water supply. The 2002 agreement anticipated that the average daily water demand would be 3.2 MGD with a maximum daily demand of 5.4 MGD, rates greater than proposed in this application. This agreement was transferred to CEC in 2014, after the 10-year requirement for municipal water purchase had been fulfilled.

Currently, treated municipal water purchased from the City of Jackson is used at JGS for evaporative cooling, steam generation, and potable use by employees. In 2019, the City discontinued the tiered-rate structure originally specified in the development agreement, and water rates subsequently increased from $1.35 per 100 cubic feet of water (plus service charges) to $3.73 per 100 cubic feet in 2021, and is planned to rise to $4.18 per 100 cubic feet in 2022. At these rates, JGS becomes a less competitive source of power to the grid. With less power being produced at the same operational overhead, the increased costs are passed along to rate payers.

To reduce consumption of municipal water, in March 2020 CEC registered to withdraw up to 1,388 gallons per minute (GPM), equal to just under 2 MGD of groundwater from a new water supply well (well PW-1) located adjacent to the JGS (Registration ID#7684-20213-10, issued March 15, 2021). The well and associated infrastructure needed to withdraw, store, and treat this water was constructed between May 2020 and April 2021, and the well became operational on April 26, 2021. The new well supplies water for non-potable applications only; treated potable water continues to be purchased from the City of Jackson for employee use, for emergency service, and for when JGS demand exceeds the withdrawal capacity for the new well. From April to September, well PW-1 supplied water at an average rate of 1.40 MGD, or approximately 55% of JGS water demand. CEC continues to purchase from the City to meet the balance of their water demand, which has averaged 1.15 MGD.

The purpose of this application is to further increase JGS withdrawal capacity, decreasing its reliance on the City of Jackson, and allowing JGS to remain a cost-competitive source of electric generation. This application seeks permitted monthly volumes that range from 124 million gallons (average rate: **4 MGD)** for the calendar month of August; to a 58 million gallons (average rate: **2 MGD)** for the calendar month of February. If JGS were to fully utilize water at these proposed rates, the average annual withdrawal rate would be **2.76 MGD**.

This permit application also seeks authorization to construct up to two additional supply wells. The proposed maximum pump capacity of each well would be **2.5 MGD per well** (1,736 GPM); however, only two wells will be pumped at once with the third well used for redundancy. The three wells would therefore be equipped to pump up to a cumulative **7.5 MGD**, although, with only two wells pumped at once, the proposed instantaneous maximum

pumping rate is **5.0 MGD** (3,472 GPM). The 5.0 MGD instantaneous maximum withdrawal capacity is necessary to deliver the 4 MGD proposed August withdrawal because the plant's generating units do not operate continuously and there is limited onsite water storage capacity (500,000 gallons).

Hydrogeologic Context

The City of Jackson is the 8th largest groundwater user in Michigan, withdrawing approximately 2.6 billion gallons per year (BGY) of groundwater from 16 wells in two wellfields. The wellfields are located along Mansion Street (1.5 miles south-southwest of JGS) and in Ella Sharp Park (2.5 miles southwest of JGS). Groundwater is treated for potable use by filtration, disinfection, and softening at the Jackson Water Treatment Plant (WTP). JGS has historically been the largest customer of the City since the plant was built. In the last 5 years (2016-2020), JGS has purchased approximately 21% of the treated municipal supply (annual average of 549 million gallons per year, or 1.54 MGD). In addition to residential and commercial customers within the city limits, Jackson also sells water to Blackman, Summit, and Leoni Townships, and to the Jackson State Prison in Blackman Township. According to City of Jackson planning documents, both the population served by municipal water, and the annual water demand, is projected to decline over at least the next 14 years.

Groundwater is withdrawn by both the City of Jackson and the new JGS supply well (PW-1) from the deep confined regional Marshall sandstone aquifer. Well PW-1 is cased to 190.5 feet below grade with 16-inch diameter steel casing. The borehole annulus between the steel casing and the geologic formations is grouted with neat cement. A 15.8-inch uncased borehole extends beyond the end of the steel casing, through bedrock, to 365 feet below grade. The well is equipped with a National Pump Company vertical turbine pump controlled by a variable frequency drive. The pump discharge is throttled to a maximum flow rate of 1,388 GPM with a Griswold valve. The proposed additional supply wells (wells PW-2 and PW-3) will be constructed on adjacent parcels that comprise parts of the JGS site. The construction specifications and projected yield of the new wells are expected to be similar to well PW-1.

Approximately 84% of the groundwater purchased by JGS is consumptively used through cooling tower evaporation. The remaining 16% is discharged to the City of Jackson sanitary sewer, which is treated and discharged to the Grand River under an existing permit from the City of Jackson. Site stormwater is discharged to the City of Jackson stormwater sewer under a No Exposure Certification from EGLE.

In support of the permit application, CEC has conducted baseline monitoring of onsite groundwater conditions beginning in May 2020. Five observation wells were drilled on the Blackman Township parcel where the supply well is located. The wells were instrumented with datalogging pressure transducers and have been recording water levels since May 2020. Three of these observation wells (OW-2s, OW-2d, OW-3) assess hydraulic characteristics of the bedrock aquifers. Two observation wells (OW-4s, OW-4d) assess groundwater conditions in the glacial overburden near a large wetland complex adjacent to the JGS site. In 2021, datalogging pressure transducers were additionally installed in 11 nearby private residential wells to evaluate local groundwater conditions. The transducers have been used to record water levels during the first several months of use, including the effects of an aquifer pumping test in July 2021.

Local hydrogeology can be described as two bedrock aquifers, separated by a regional confining unit (the Saginaw confining unit). On the JGS site, the glacial overburden is not an aquifer and primarily composed of clay and silt, with interbedded sand lenses. The potentiometric surface in the glacial overburden and/or the Saginaw sandstone aquifer (i.e., above the Saginaw confining unit) is about 20 to 30 feet higher than the potentiometric surface of the Parma and Marshall aquifers (i.e., below the Saginaw confining unit). The steep downward gradient across the

Saginaw confining unit is attributable in part to regional pumping from the confined Marshall sandstone aquifer by the City of Jackson, Summit Township, and other municipalities.

Projected Effects of the Withdrawal

Approximately 130 water well records in neighborhoods near JGS were reviewed to characterize local geology and risks to existing groundwater users. Most residential neighborhoods near JGS in Blackman and Summit Townships are served by municipal water, as are the commercial corridors along Page Avenue (southeast of JGS) and East Michigan Avenue (northeast of JGS). However, many residences in Leoni Township east to southeast of JGS remain on private wells.

To define and illustrate the effects of the proposed withdrawal, a numeric groundwater model was constructed, based in part on a United States Geologic Survey (USGS) regional groundwater flow model and a local groundwater model developed for Jackson County. The model has been calibrated to an aquifer test completed at well PW-1 in July 2021.

Of the 130 water well records reviewed for the project, approximately one-half of the private wells are completed in either the glacial overburden or Saginaw sandstone aquifer, with depths of generally less than 120 feet deep. Wells such as these, completed above the Saginaw regional confining unit, are hydraulically isolated from the Marshall aquifer. The other one-half of private wells are generally completed in the Parma aquifer, between approximately 150 to 200 feet deep, with a few commercial wells drilled to the Marshall sandstone.

The sensitivity of Parma aquifer private wells to high-capacity withdrawals is complex and depends primarily on whether or not the well creates a conduit across the Saginaw confining unit. Most private bedrock wells are constructed by drilling a few feet into the top of the uppermost competent bedrock unit, where a surface casing is installed and secured with cement grout. Once the grout is set, a smaller uncased borehole is drilled beyond the end of the casing until sufficient water is obtained. East and north of JGS, the uppermost unit is the Saginaw sandstone, and well casings only seal off the upper few feet of Saginaw sandstone, not the entire unit. These wells therefore still receive water from the Saginaw sandstone and have a water level consistent with the Saginaw sandstone, around 950 to 960 feet above mean sea level (amsl), even if the uncased portion of the well breaches the confining unit into the Parma aquifer. However, southeast and south of JGS, the uppermost unit is the Saginaw confining unit (shale and limestone). Wells cased into the Saginaw confining unit cannot receive water from the overlying Saginaw sandstone unit, and therefore have static water levels consistent with the Parma and Marshall formations, around 920 to 930 ft amsl. These wells are sensitive to high-capacity groundwater withdrawals from the deep aquifer.

For this reason, it is expected that any interference complaints are most likely to originate east to southeast of JGS, in the NW1/4 of Section 6, Leoni Township. Based on groundwater monitoring and model projections, approximately 5 to 10 feet of additional drawdown is expected in residential neighborhoods related to the proposed withdrawal. CEC accepts that pump intakes at some private residential wells could potentially be exposed when the private well pump is activated, causing the pump to entrain air. Two private wells in this neighborhood continue to monitor aquifer drawdown in this area. Of note, after seven months (April to November 2021) of pumping at a long-term average rate of approximately 1.4 MGD, no well interference complaints have been reported. In nearly all instances the interference could be mitigated by resubmerging the pump intake by adding a standard 20-foot length of drop pipe.

Wetlands near the JGS site and throughout the City of Jackson are physically and hydraulically separated from the confined Marshall sandstone bedrock aquifer. Water levels measured in observation wells OW-4s and OW-4d

demonstrate that the large wetland complex along Roberts Road near JGS is perched relative to the bedrock aquifer, and that there is no hydraulic connection between the wetland and the Marshall aquifer. There are no perennial streams in the area connected to the Marshall aquifer. It is inferred that the City's Mansion Street wellfield, located adjacent to the Grand River, has no measurable hydraulic connection to the river and its adjacent wetlands. However, even if there was a hydraulic connection, a reduction in the City's groundwater withdrawal by relocating a portion of the withdrawal to JGS would result in a net increase in water levels in the Grand River and adjacent wetlands.

Private Property Contingency Plan

CEC has prepared a private property contingency plan to assess and mitigate private well complaints if any well interference is experienced by nearby residents and businesses. CEC has met with Jackson County Health Department (JCHD) to inform them of the Plan, and to coordinate any necessary response to homeowners or businesses potentially affected by the proposed withdrawal.

Private property owners concerned that their well is entraining air will be directed to contact their Township administration (Leoni, Blackman, or Summit Townships), and/or the JCHD. JCHD will in turn contact the CEC Community Affairs department. Should CEC be contacted directly by a resident, the CEC Community Affairs department will inform JCHD of the referral. JCHD will be responsible for tracking addresses of any incoming well complaints to evaluate if a geographic pattern exists, and to ensure that complaints are adequately addressed.

CEC will retain one local well driller, one pump installer, and an environmental consultant to investigate and address any legitimate concerns that the installation and operation of JGS wells are having an impact on nearby wells. A contractor will be dispatched to the private well within 2 business days of receiving written notification of an alleged issue. The contractor will establish the nature and cause of the issue and verify if the issue is reasonably related to CEC's well installation or operation. JCHD and CEC will be informed of the contractor's findings in writing and will participate in discussions regarding CEC's responsibilities and proposed mitigation. If JCHD and CEC agree that CEC is likely responsible, the appropriate well mitigation or hook-up to municipal water will be undertaken at CEC's expense.

It is expected that nearly any interference complaint would be mitigated by lowering the well pump through the addition of a 20-foot length of drop pipe. Static water levels in Leoni Township east and southeast of JGS are around 50 feet below grade; well depths are generally 150 to 200 feet below grade, allowing sufficient clearance for lowering the pump. Wells completed at shallower depths (i.e., 80 feet deep), where there may be limited clearance to lower the pump, will not be impacted by the withdrawal because the well is completed above the Saginaw confining unit.

CEC will continue to monitor hydrologic conditions and further study the effects of the proposed withdrawal on aquifer water levels. If the well complaint is not consistent with regional observations, CEC will discuss findings with JCHD. If JCHD agrees that the well complaint is unlikely to be related to CEC, the property owner will be responsible for their well's repairs, but CEC will not seek reimbursement for evaluating the well.

If any complaints are received, the time and expense to address the complaint would be categorized by CEC as an "emergent issue", the terminology required for rate case documentation. CEC reserves budget for emergent issues through multiple funding mechanisms. The JGS water supply project has a small contingency for emergent issues, and projects which are tracking below budget can also be used to fund emergent issues. Additionally, JGS maintains a small pool of money with which to address emergent issues.

Conclusion

This application information package provides additional data and documentation necessary to evaluate the environmental, hydrologic, and hydrogeologic conditions that exist at the site, and the predicted effects of the increased withdrawal. CEC believes that the proposed withdrawal meets the applicable standards of Part 327. CEC respectfully requests that approval be issued allowing the following:

1) Construction of up to two additional wells with a proposed maximum pump capacity of 2.5 MGD per well (1,736 GPM), with the caveat that only two of the three total installed wells will be pumped at once, and

2) The increased withdrawal capacity as outlined within this application.

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ATTACHMENTS

1.0 SECTION 1: APPLICANT INFORMATION

Consumers Energy Company (CEC) is the applicant for the Jackson Generating Station (JGS) project, located at 2219 Chapin Street, Jackson, MI, 49203. Ms. Rachel Proctor, P.E. ( ) is the applicant's representative, and may be reached by phone at , or CEC's mailing address of 1945 W. Parnall Rd., P22-328, Jackson, MI 49201.

2.0 SECTION 2: PROPOSED WATER WITHDRAWAL INFORMATION

a) Water Source and Pump Information

Groundwater is proposed to be withdrawn from up to three wells located on parcels adjacent to the JGS. Well PW-1 was constructed in May and June 2020 on Blackman Township parcel (ID# 000-08-36-409-004-00 - Figure 1). Well PW-2 is proposed to be constructed on the same parcel, and well PW-3 is proposed to be constructed on an adjacent parcel (ID# 420-13-01-201-001-02) in Summit Township (Figure 1). The proposed coordinates for the three locations are provided on Table 1:

Table 1: Proposed and Existing Supply Well Locations

	Status	Northing	Easting
Well PW-1	Constructed June 2020, operational April 2021	272930.11	13121208.89
Well PW-2	Proposed	~272430	~13121200
Well PW-3	Proposed	~272080	~13121200

Michigan State Plane, NAD83(2011), South Zone International Feet

Well PW-1 is 365 feet deep and was drilled using a combination of mud and air rotary methods. The 16-inch steel well casing extends from 18 inches above the ground surface, to 190.5 feet below grade. The 2-inch annulus between the well casing and the geologic formations was grouted with neat cement to prohibit surface water and upper groundwater from entering the well via the borehole annulus. Beyond the end of the casing, a 15.8-inch diameter bedrock borehole extends to 365 feet below grade. The EGLE water well record is provided as Attachment A-1.

The well draws water from the prolific Marshall Sandstone aquifer. A "Zone A" withdrawal of 1,350 GPM was registered with the State of Michigan (Registration ID #7684-20213-10) on March 11, 2020 and revised on March 15, 2021 with a "Zone A" withdrawal of 1,388 GPM (Attachment A-2). In March 2021, well PW-1 was equipped with a National Pump Company vertical turbine pump, controlled by a variable frequency drive. The pump discharge is currently throttled with a Griswold valve to a maximum flow rate of 1,388 GPM (Attachment A-3). Wells PW-2 and PW-3 are anticipated to be drilled to similar depths and have similar construction to well PW-1. Following construction and testing, both wells are anticipated to be equipped with similar pumping equipment as well PW-1.

CEC seeks to increase the maximum withdrawal rate of supply well PW-1 from **2 MGD** to **2.5 MGD;** and to construct and equip wells PW-2 and PW-3 to withdraw **2.5 MGD** each. The wells would therefore be equipped to pump up to 7.5 MGD, although with only two wells operated at once, and the third remaining in a redundant capacity, the proposed maximum pumping rate is **5.0 MGD**.

The reason for seeking 5 MGD as the maximum instantaneous rate is because the wells cannot be pumped at their maximum rates 24 hours per day due to limitations on water storage (one 500,000 gallon tank) and generation schedule (generally 16 hours per day). Although registered for 2 MGD, the withdrawal rate of PW-1 in August 2021 (highest use month to date) was 1.6 MGD, or about 80% of the 2 MGD (1,388 GPM) registration.

b) Proposed Maximum Withdrawal per Month

Monthly water use at JGS is greatest in summer, due to both greater electric demand in the summer months and lower evaporative efficiency during hot and humid conditions. The proposed withdrawal rates, as discussed in the following sections, were selected following an analysis of historical water purchase records, and projected future use of the facility.

Monthly purchase records from January 2016 through September 2021 illustrate the seasonality of JGS water usage (Figure 2). From 2016 to 2020, JGS purchased between 518 and 615 million gallons (1.42 to 1.68 MGD), averaging 549 million gallons (1.54 MGD) over 5 years. In 2020, water usage was 520 million gallons, less than normal due to an extended plant outage during a major upgrade; and in summer 2021 one of the combined cycle units was offline due to timing for equipment repairs. Historically, July has been the calendar month with the highest average usage (2.60 MGD). The maximum monthly usage during this period was 117,200,000 gallons in August 2016 (average daily rate: 3.78 MGD), and the minimum monthly volume was 4,400,000 gallons in May 2020 (average daily rate: 0.14 MGD), during the forementioned major upgrade.

The proposed maximum withdrawal rates for the combined groundwater system are outlined in Table 2:

Table 2: Proposed Maximum Monthly Water Withdrawal Volumes

Month	Maximum Monthly Use, 2016-2020 (MGD)	Proposed Maximum Monthly Withdrawal Rate (MGD)	Proposed Maximum Monthly Withdrawal Volumes (Million Gallons)
January	1.6	2	62
February	1.3	2	58
March	1.6	2.5	77.5
April	1.9	2.5	75
May	1.8	3	91
June	3.1	3.5	105
July	2.9	3.5	108.5
August	3.8	4	124
September	2	3	90
October	2	2.5	77.5
November	1.9	2.5	75
December	1.5	2	62

If JGS were to fully utilize water at these proposed rates, the annual withdrawal would be 1.007 billion gallons (2.76 MGD), approximately 79% higher than the 1.54 MGD historical purchase from the City (2016-2020); and 38% more than was authorized through the March 15, 2021 Registration.

c) Primary Purpose of Use

The proposed withdrawal will supply water to the JGS for use in evaporative cooling towers and the power generation units. The withdrawal will not be used for the potable needs at the facility. JGS will remain connected to the Jackson municipal supply for potable water needs, for emergency use, and for periods when water demands approach Registered or Permitted withdrawal limits.

3.0 SECTION 3: PROPOSED RETURN FLOW DISCHARGE INFORMATION

Wastewater from the site, including the cooling towers, will continue to be discharged to the City of Jackson sanitary sewer north of the JGS, near the corner of Chapin and South Forbes Streets (Figure 1) under its existing wastewater permit from the City of Jackson. The sanitary sewer directs water to the City of Jackson Wastewater Treatment Plant (WWTP) on River Street in Blackman Township. The WWTP discharges treated water to the Grand River.

Based on four years of discharge records (August 2017 through July 2021), JGS discharges an average of 256,000 gallons per day (GPD), or an average daily rate of 178 GPM, to the sanitary sewer system (Figure 3). The daily wastewater discharge rate is highly variable, depending primarily on the frequency and timing of the cooling tower blowdown events, which in turn depend on the generation schedule. During the last three years, the maximum monthly discharge rate was 477,127 GPD (331 GPM) in July 2020; and the minimum was 17,966 GPD (12.5 GPM) in May 2020. Historically, the ratio of purchased treated water to wastewater discharge is approximately 6:1; for every six gallons of water purchased, one gallon is discharged, with the balance being evaporated in the cooling towers.

The CEC discharge permit allows a maximum daily discharge of one million GPD.

4.0 SECTION 4: EVALUATION OF EXISTING HYDROLOGIC AND HYDROGEOLOGIC CONDITIONS

Hydrologic and hydrogeologic conditions at JGS property and surrounding areas have been evaluated through:

- Review of geologic publications, geologic mapping, and USGS and EGLE data;
- Review of approximately 130 private local water well records, and the City of Jackson water well records;
- Exploratory drilling on the CEC-owned parcel, completing five new observation wells in addition to new supply well PW-1;
- Water level monitoring of the new supply well, five onsite observation wells, and 11 private wells; and
- Aquifer testing.

A conceptual understanding and mathematical representation of the local hydrogeology has been synthesized into a groundwater model (Attachment B), based in part on previous models authored by USGS[1], and Williams & Works[2]. The primary purpose of the model has been to describe and illustrate aquifer drawdown in nearby areas as a function of the new proposed withdrawal, and the corresponding reduction in the City of Jackson's current withdrawal.

4.1 Hydrology

The JGS project site is located in the Upper Grand River watershed (Figure 4). The Grand River forms from tributaries near the Jackson and Hillsdale county line and flows generally northward through central Jackson County and the City of Jackson. The western portion of Jackson County is located in the Kalamazoo River watershed, and the southeastern portion is located within the River Raisin watershed. With respect to the Water Withdrawal Assessment Tool (WWAT), the site is located in catchment #21084, which is the Center Lake tributary to the Grand River (Figure 5).

The following sections summarize relevant local and regional hydrologic characteristics, with additional details provided with the groundwater model (Attachment B).

4.1.1 Precipitation

The nearest long-term weather station to JGS is located at the Jackson County Airport (Jackson Reynolds Field, USW00014833) approximately 4.5 miles west of the site. The period of record extends from 1948 to the present. The 30-year average (1980-2010 Normal) annual precipitation is 31.5 inches. Annual precipitation has increased at a rate of 0.6 inches per decade over the period of record. However, over the last 20 years, annual precipitation has increased at a rate of 2 inches per decade. During each of the last 5 years, annual precipitation has exceeded the 1980-2010 Normal (Figure 6).

4.1.2 Topography

Surface elevations in Jackson County range from approximately 1,150 ft above mean sea level (amsl) in the southwestern portion of Jackson County, to approximately 890 ft amsl where the Grand River crosses the county's northern border near Rives Junction (Figure 7). Near the JGS site, surface elevations range from roughly 1,000 ft amsl along Tyson Avenue to the north; to approximately 955 ft amsl at the wetlands complex east of Roberts Street (Figure 8). Locally, the lowest surface elevation is approximately 930 ft amsl along the Grand River channel.

4.1.3 Surface Water

The Grand River flows southeast to northwest through downtown Jackson about 1 to 1.5 miles south and southwest of JGS (Figure 9). The nearest stream gauge is located near the City of Jackson Wastewater Treatment Plant (WWTP) north of Jackson on River Street. The gauge has operated since April 1935 and has an upstream area of 174 mi^2. The average flow at the gauge for the full record is 59,470 GPM, the median flow is 44,800 GPM, and the index flow is 24,011 GPM, with September being the lowest flow month (based on the full 1935-2021 record).

[1] Feinstein, D.T., Hunt, R.J., and Reeves, H.W., 2010, Regional groundwater-flow model of the Lake Michigan Basin in support of Great Lakes Basin water availability and use studies: U.S. Geological Survey Scientific Investigations Report 2010–5109, 379 p.

[2] Williams and Works, 2002, Wellhead Protection Area Delineation, Jackson County Community. December

The Grand River (Figure 5, Segment #21750) is classified as a warm small river, with a base flow[3] estimated by EGLE to be 52,317 GPM at the stream gauge, with an index flow[4] of 25,137 GPM. The Center Lake tributary (Figure 5, Segment 21084) is classified as a warm stream, with a base flow estimated to be 20,147 GPM, and an index flow of 10,223 GPM.

There are no perennial streams within a one-mile radius of JGS (Figure 9). Surface water at JGS is captured by the stormwater system, which either infiltrates through onsite stormwater basins or flows to municipal stormwater mains which collect and direct runoff to the Grand River. Surface runoff on the well parcel flows east to roadside ditches and the wetland along Roberts Street. The wetland is drained by infiltration to groundwater and by evapotranspiration. There are no perennial or intermittent streams entering or leaving the wetland.

JGS returns approximately one-sixth of its water purchase to the City of Jackson WWTP as return flow (annual average wastewater discharge of 256,000 GPD, or 178 GPM). This discharge volume of 178 GPM constitutes approximately 0.34% of the base flow (52,317 GPM) of the Grand River at USGS Gauge 04109000, or 0.7% of the Grand River index flow (24,011 GPM).

4.1.4 Wetlands

Numerous wetlands are present in the vicinity of JGS, with an 11.2-acre wetland directly east and southeast of JGS. Additional wetlands are located within a mile of JGS to the north, east, and southeast (Figure 10). The surface elevation of these wetlands is between 950 and 960 ft amsl, or about 20 to 30 feet higher than the potentiometric surface of the deep bedrock aquifer. As discussed in the following section (4.2, Stratigraphy), the regional Saginaw confining unit physically and hydraulically separates the surficial wetlands, glacial overburden, and shallow bedrock from high-capacity withdrawals from the deep Marshall aquifer. The wetland hydrology is therefore not affected by the proposed groundwater withdrawal. Hydrographs of groundwater adjacent to the wetland are provided in Section 4.2.1.

The most extensive local wetlands are located between 1 and 3 miles south to southeast of JGS along the main branch of the Grand River, and its Center Lake tributary (Figure 11). The surface elevation of these wetlands is approximately 930 to 935 ft amsl. Although the elevation of these wetlands is close to the potentiometric elevation of the Marshall aquifer, there is no evidence of a hydraulic connection between the Marshall aquifer and surficial wetlands. Of note, wells in the City of Jackson's Mansion Street wellfield are located within 200 yards of the Grand River channel and wetlands. The City's withdrawals from the deep Marshall sandstone aquifer are inferred to have no impact on Grand River flows, levels, or the hydrology of adjacent wetlands. However, even if the City withdrawal could affect the Grand River and associated wetlands, relocating a portion of the City's withdrawal to JGS and decreasing the withdrawal at the Mansion Street wellfield would have a net positive effect on the Grand River and wetlands.

4.1.5 Existing Groundwater Withdrawals

Regional water use is dominated by the City of Jackson municipal groundwater supply. The City of Jackson draws water for municipal supply from two active wellfields, with 12 wells in the Mansion Street wellfield, and 4 wells at the Ella Sharp Park wellfield. In 2020, the municipal withdrawal was the eighth-largest groundwater withdrawal in Michigan at 2.467 billion gallons. Over the past 23 years (1998-2020), the average annual withdrawal has been 2.54 billion gallons per year (BGY), equivalent to 6.96 MGD or 4,830 GPM. During these years, annual

[3] "Base Flow of Michigan Streams", Michigan Department of Natural Resources Open Data GIS Layer

[4] Water Withdrawal Assessment Tool, State of Michigan EGLE. Index flow is the median flow during the calendar month with the lowest flow.

withdrawals ranged from a minimum of 2.24 BGY to a maximum of 2.89 BGY (Figure 12). Regional water use is projected to decline[5]. The City of Jackson is projected to decrease in population by 6%, or about 2,000 individuals over the next 15 years; and the total population served, including the adjoining Townships and the Jackson State Prison, is expected to decline 2.6%. Total water sales are projected to decline 2.6% from 6.05 MGD to 5.89 MGD. At the time that the report was published, these projections did not account for utilization of the new well PW-1 for JGS supply, rather than the municipal wellfield. The decreasing regional trend supports that the increased withdrawal by JGS is unlikely to interfere with other high-capacity water users.

Over the past 5 years, JGS has on average purchased 21% of Jackson's municipal supply (Table 3):

Table 3: City of Jackson and JGS Usage (2016-2020)

	Jackson Usage (Gallons)	JGS Usage (Gallons)	JGS Usage (MGD)	Percentage of Municipal Supply Purchased by JGS
2016	2,877,150,000	615,020,000	1.68	21.3%
2017	2,674,030,000	518,549,020	1.42	19.4%
2018	2,693,590,000	572,198,682	1.57	21.2%
2019	2,631,700,000	589,349,941	1.61	22.4%
2020	2,467,310,000	519,919,297	1.42	21.1%

Other high-capacity groundwater withdrawals in Jackson County include Summit Township (880 million gallons in 2020, or 1,674 GPM), Leoni Township (137 million gallons, or 260 GPM) and the Sparks Foundation Park (120 million gallons, or 228 GPM). There have been no new high-capacity withdrawals registered with the State within 3 miles of JGS since the new withdrawal legislation became effective in April 2009.

The nearly 7 MGD City of Jackson municipal withdrawal significantly influences water level regionally. From July 2020 to April 2021 baseline monitoring was conducted prior to JGS supply well PW-1 becoming operational. Water levels at supply well PW-1 ranged approximately 16 feet from 910 ft amsl on July 10, 2020 to 926 ft amsl on January 17, 2021 (Figure 13). The majority of this variation is inferred to be attributed to variations in the City of Jackson's seasonal water demand.

4.2 Stratigraphy

The following discussion and stratigraphic cross-sections (Figures 14a and 14b) describe the four aquifers and two confining units relevant to the project, based on drilling observations, geologic mapping, and an extensive review of local water well records. Boring logs for the onsite wells and the 11 instrumented private wells are provided in Attachment A-4.

4.2.1 Glacial Overburden

The JGS site is mapped as being located on an end moraine of coarse-textured till, and close to a channel of glacial outwash sand and gravel generally located along and parallel to the Grand River (Figure 15). Locally,

[5] Fishbeck (2021). City of Jackson Draft Drinking Water State Revolving Fund Project Plan. April

water well records indicate that the glacial overburden consists of sediments ranging in texture from sand to clay, with a thickness of generally less than 70 feet.

At JGS, the glacial overburden consists primarily of clay till, with a 2-foot thick lens of water-bearing silty sand near the bottom. Two observation wells (OW-4s and OW-4d) were installed in the overburden about 340 feet southeast of the supply well, near the wetland east of the property along Roberts Road. Observation well OW-4s is screened from 9 to 14 feet below grade (954 to 949 ft amsl) and was constructed to monitor shallow groundwater levels, inferred to be connected to the wetland along Roberts Street. The water level in well OW-4s is approximately 955 ft amsl, approximately equivalent to the water level in the wetland. The uppermost 10 feet at well OW-4s consists of graded gravelly sand fill, presumably placed during construction and/or demolition of former buildings on the parcel. Below the sand fill, 8 feet of chipped wood fill was encountered (10 to 18 feet below grade), and 2 feet of peat (18 to 20 feet below grade). It is believed the chipped wood fill derived from trees on the property prior to its initial development 80 to 100 years ago, and that the waste wood was deposited into the wetland as fill. Peat underlying the wood chips likely represents the natural base of the wetland.

From 20 to 60 feet below grade, the overburden consisted primarily of silty clay and clayey silt. A thin silty sand and gravel lens was encountered at 44 to 46 feet below grade and was judged sufficiently saturated to transmit water to an observation well. Observation well OW-4d was installed from 41 to 46 feet below grade. The top of the bedrock surface was encountered at 60 ft bgs (903 ft amsl).

The silty clay between 20 and 44 feet below grade physically and hydraulically separates the upper saturated sand and wood chips where OW-4s is screened, from the lower silty sand lens where OW-4d is screened. The potentiometric surface at OW-4s (955 ft amsl) is consistently approximately 4.5 to 5 feet higher than at OW-4d (950 to 950.5 ft amsl), with a consistent downward hydraulic gradient (Figure 16).

Locally, few private wells are screened in the overburden; the highest concentration of overburden wells near the study area are located in a Blackman Township neighborhood (Whitlock Drive) over a mile northeast of the site. Water well records indicate that these wells have greater thicknesses of sand and gravel than observed at the JGS site.

4.2.2 Regional Bedrock Geology

Regionally, there are three significant water-bearing bedrock aquifers discussed in detail in the following section:

- the Saginaw aquifer;
- the Parma/Bayport (P/B) aquifer;
- the Marshall aquifer.

All three aquifers can support relatively low-yielding wells needed for most residential, commercial, and residential irrigation purposes, but only the deepest of these aquifers, the Marshall aquifer, yields sufficient water for high-capacity municipal and industrial wells.

There are two aquitards that resist the vertical movement of water between the aquifers:

- the Saginaw confining unit, located between the Saginaw aquifer and the P/B aquifer;
- the Michigan formation, located between the P/B aquifer and the Marshall aquifer.

A regional aquiclude, the Coldwater shale, underlies the Marshall aquifer and defines the base of regional freshwater resources.

The uppermost bedrock unit is mapped as being highly variable in the study area (Figures 17A and 17B). The regional bedrock map places the Michigan formation as the uppermost bedrock unit at the JGS site; and places a small area of Marshall sandstone as the uppermost bedrock unit, northeast of the site along East Michigan Avenue. However, based on borehole logs from onsite wells and nearby residential well records, it is Golder's observation and interpretation that the Saginaw aquifer is the uppermost unit at JGS well PW-1, as well as in areas generally north of an approximate east-west line through the JGS site. South of the line, the Saginaw confining unit is the uppermost bedrock unit; the Saginaw aquifer was not observed at observation well OW-3 and does not appear in most residential water well records to the south and east of JGS.

4.2.2.1 Saginaw Formation

The Saginaw formation is the uppermost and youngest bedrock unit at the JGS site. The Saginaw formation is thickest to the north, but thins toward the south across the study area.

The Saginaw formation consists of an aquifer and an underlying confining unit. The aquifer consists primarily of a unique bluish-white sandstone, which is fissile (frequently logged as "soft" or "broken") and often highly fractured with large voids. Residential wells completed in the Saginaw are generally 60 to 120 feet below grade, with water levels generally 10 to 30 feet below grade. The specific capacity[6] of residential wells completed in the Saginaw aquifer is relatively high, generally between 1 and 3 GPM/ft or greater.

The base of the Saginaw formation consists of shale, with thin layers of sandstone, siltstone, limestone, and coal, that hydraulically separate the overlying Saginaw aquifer from the underlying P/B and Marshall aquifers. The Saginaw confining unit is approximately 50 feet thick and is readily identifiable on many residential well records.

The majority of local private residential wells in the area are cased into the Saginaw formation. If the wells are cased into the Saginaw sandstone aquifer, but are not fully sealed through the entire Saginaw sandstone into the confining unit, the water level in the well generally reflects the potentiometric head of the sandstone (around 950 to 955 feet amsl) regardless of the well depth, or the aquifer in which it terminates. If the wells are cased and sealed into the Saginaw confining unit, the water level in the well reflects the potentiometric head of the underlying Parma or Marshall sandstones (around 920 to 930 feet amsl).

4.2.2.2 Parma Sandstone/Bayport Limestone Aquifer

The Parma sandstone is a medium- to coarse-grained sandstone that is frequently identifiable in well records as a 50- to 70-foot thick homogeneous, massive gray sandstone unit. The Bayport limestone is a fossiliferous, cherty limestone with interbedded sandstone that underlies the Parma sandstone. Due to its interbedded nature, the Bayport limestone is not as readily distinguishable in well logs as the Parma sandstone. The lateral continuity of the Bayport is difficult to map as most local private wells terminate in the Saginaw or Parma aquifers which generally supply sufficient water for residential needs, so drilling to the Bayport limestone is unnecessary. The

[6] Specific capacity is defined as the rate at which a well can be pumped per unit drawdown, typically in gallons per minute per foot (GPM/ft) and can be calculated from reported information on many Michigan water well records.

USGS considers the Parma and Bayport to be interbedded and hydraulically connected, and therefore refers to the combined units as a single aquifer[7].

At the JGS property, the Parma sandstone was observed from approximately 130 to 180 feet below grade. Observation well OW-2s on the JGS property is completed in the Parma sandstone. The Parma sandstone and Bayport limestone are characterized by very low specific capacities (typically 0.5 GPM/ft or less). The aquifer is rarely used for water supply and there are no known aquifer tests from the Parma/Bayport aquifer[7] Based on the USGS precedent, this memo combines the Parma and Bayport units as the Parma/Bayport ("P/B") aquifer.

4.2.2.3 Michigan Formation

The Michigan formation underlies the Bayport limestone and consists of layers of sandstone, siltstone, anhydrite or gypsum, dolomite, limestone, and shale. The Michigan formation is considered a confining unit that separates the P/B aquifer from the Marshall aquifer[8]. However, at the JGS supply well, lithology identified as either the Bayport limestone and/or Michigan formation have a combined thickness of approximately 50 feet, and the units are virtually indistinguishable from each other. Water level drawdown in wells such as observation well OW-2s and wells cased into the Parma sandstone to the southeast suggest that the confining properties of the Michigan formation (i.e., shale beds) are effectively absent in this area, resulting in hydraulic connection between the underlying Marshall aquifer and the overlying P/B aquifers.

4.2.2.4 Marshall Aquifer

The Marshall aquifer consists of 200 feet or more of permeable and highly-transmissive sandstone, and is the only regional aquifer than can support high-capacity supply wells. The City of Jackson operates 16 municipal public water supply wells that withdraw water primarily from the Marshall sandstone. Private wells completed in the Marshall have specific capacities an order of magnitude greater than the Parma sandstone (i.e., 1 to 10 GPM/ft), with large-diameter supply wells having specific capacities as much as 50 GPM/ft. The transmissivity of the Marshall aquifer is documented by USGS as ranging between 7,500 and 29,000 ft^2/day[9]. As discussed below in Section 4.4, aquifer testing of the JGS supply well indicates a local transmissivity of 8,000 to 9,000 ft^2/day, and a storativity of 1E-04 to 3E-04 (unitless). The Marshall grades to fine sandstone and siltstone with depth, with occasional thin units of limestone and shale. At the site, the Marshall sandstone was observed from 220 to 420 feet below grade, with the greatest increase in water production observed between approximately 220 and 280 feet below grade.

4.2.2.5 Coldwater Shale

The Coldwater formation is a massive shale aquitard underlying the Marshall sandstone, in which and below which there are no known freshwater resources. The Coldwater shale is generally between 700 and 1,000 feet thick. The top of the Coldwater shale was encountered at observation well OW-3 at 420 feet below grade.

[7] Westjohn, D.B. and Weaver, T.L. (1996). Hydrogeologic Framework of Mississippian Rocks in the Central Lower Peninsula of Michigan. U.S. Geological Survey, Water-Resources Investigations Report 94-4246.

[8] Beth, A.A and Reeves, H.W. (2007). Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p.

[9] Westjohn, D.B. and Weaver, T.L. (1996). Hydrogeologic Framework of Mississippian Rocks in the Central Lower Peninsula of Michigan. U.S. Geological Survey, Water Resources Investigation Report 94-4246. 46 p.

4.3 Hydrogeology

Local and regional hydrogeology has been evaluated through the review of water well records, local and regional models and publications, an onsite drilling and testing program which began in May 2020, and from datalogging transducer records from nearby private wells.

4.3.1 Supply Well PW-1

JGS supply well PW-1 was constructed by Peerless-Midwest (Mishawaka, IN) in May and June 2020 as authorized by Jackson County Health Department Permit #19929. A 22-inch diameter borehole was drilled through the overburden, and the Saginaw and Parma bedrock units to a depth of 190.5 feet below grade, where a 16-inch diameter steel casing was installed and secured with neat cement grout. After curing the grout for 48 hours, a 15.8-inch diameter borehole was extended beyond the end of the casing to 365 feet below grade.

The well was partially developed during air-rotary drilling, but upon completion, the well continued to be developed to clear the well of fines. Turbidity in the air-purged water was reduced to 11 nephelometric turbidity units (ntu).

On June 29, 2020 a temporary turbine pump was installed in the well for testing and final development. On June 30, the pump purged the supply well at a rate of approximately 1,350 GPM for 5.5 hours, and on July 1, the well was purged at 1,350 GPM for an additional 3.5 hours. During the longer test on June 30, the water level in well PW-1 declined 21.47 feet in 5.5 hours, for a short-term specific capacity of 62.9 GPM/ft.

To evaluate long-term specific capacity, the daily average water level in well PW-1 was plotted and regressed against its daily average pumping rate using data from June 8, 2021 to September 20 (Figure 18). The daily average pumping rate during this time, which included a week of aquifer testing in July 2021, ranged from 1.95 MGD to 0.00 MGD (recorded during a recovery phase of the aquifer test). The linear regression of pumping rate vs. water level is effectively the specific capacity of the well – for every 1 MGD (694 GPM) pumped, water levels decline 14.17 feet, for a specific capacity of 49 GPM/ft. At the proposed maximum rate of 2.5 MGD, in-well water levels are projected to decline 35.4 feet.

The static water level is approximately 917 ft amsl, or 54.6 feet below the top of casing. At 2.5 MGD, with 35.4 feet of in-well drawdown, the water level will be approximately 90 feet below the top of casing (883.6 ft amsl). Water levels are therefore expected to remain well above the pump intake, set at 130 feet below the top of casing.

4.3.2 Onsite Observation Wells and Offsite Private Wells

Five observation wells were drilled on the parcel where supply well PW-1 was constructed (Figure 1). Table 4 summarizes the construction details of the wells, with boring logs included in Attachment A-4.

Table 4: Construction Details, Production Well and Onsite Observation Wells

	Casing Depth	Screened Interval	Total Depth	Northing	Easting	Radial Distance from PW-1	Formations
PW-1	190.5	NA	365	272930.1107	13121208.85	0	Marshall
OW-2S	122	NA	170	272917.4937	13121408.09	200	Parma SS
OW-2D	150	NA	315	272911.7617	13121409.89	201	Parma SS and Marshall SS
OW3	218	NA	420	272425.0267	13121200.36	505	Marshall SS
OW-4S	NA	9-14	14	272649.3017	13121398.54	339	Overburden
OW-4D	NA	41-46	48	272643.3387	13121397	343	Overburden

Michigan State Plane, NAD83(2011), South Zone International Feet

Additionally, agreements were reached with private well owners in the neighborhoods generally northeast to southeast of JGS, with 11 private wells being surveyed and instrumented with dataloggers (Figure 19). Table 5 summarizes the construction details of the wells, with boring logs also included in Attachment A-4.

Table 5: Construction Details, Instrumented Private and Residential Wells

	Casing Depth (ft)	Total Depth (ft)	Northing*	Easting*	Radial Distance from PW-1 (ft)	Formations
2602 Chapin	60	122	272930.11	13121208.85	812	Saginaw SS
334 Watts	66	102	273375.57	13121960.05	989	Saginaw SS
429 S. Dettman	75	181	273425.14	13123902.43	2739	Saginaw SS and Parma SS
226 Briscoe	70	102	274827.60	13124105.03	3462	Saginaw SS
3150 Mott	39	76	273807.44	13124350.52	3261	Saginaw SS
3141 Sparks	101	157	271749.20	13124402.86	3405	Parma SS
3213 Perlman	75	180	272178.72	13124738.69	3609	Parma SS
539 Sheridan	65	180	272666.19	13124938.74	3739	Saginaw SS and Parma SS
357 Sheridan	50	80	273785.14	13124985.40	3872	Saginaw SS
323 Seneca	94	200	276788.23	13122985.00	4247	Parma or Marshall SS
3500 Ann Arbor	73	245	276799.14	13127067.28	7021	Saginaw, Parma, and Marshall SS

*Michigan State Plane, NAD83(2011), South Zone International Feet

Datalogging transducers have been installed in the supply well and five onsite observation wells since their installation in May and June 2020. Datalogging transducers were installed in the 11 private wells in Blackman and

Leoni Townships beginning in March 2021, with the latest installations in July 2021. The purposes of the onsite monitoring and private well monitoring program has been to:

- Measure regional static water levels, assess interactions between aquifers, and map groundwater flow directions.
- Assess characteristics of individual private wells.
- Quantify the effects of the JGS supply well and City of Jackson municipal wellfield withdrawals on private wells completed in different aquifers.
- Measure drawdown at varying depths and radial distances from pumping wells, for use as calibration targets for the groundwater model.

The wells selected for instrumentation are intended to be representative of other wells within the same neighborhood. Most of the instrumented private wells are located between S. Dettman Road and Sheridan Road (Neighborhoods “B” and “D” (Attachment C), in areas most likely to be affected by the proposed JGS withdrawal.

4.3.3 Groundwater Flow

Based on water level measurements and aquifer response to pumping (both the City of Jackson wells, and JGS supply well PW-1), the aquifer units and two confining units discussed in Section 4.2.2 are hydraulically-connected or disconnected as follows:

- The fill sand at the top of the onsite overburden is physically and hydraulically separated from a thin silty sand unit observed at the base of the overburden. A downward vertical gradient of approximately 5 feet (observation well OW-4s to OW-4d, vertical separation of 32 feet) has been observed for 18 months (0.16 ft/ft). The static water level in the adjacent shallow observation well OW-4S is approximately 955 ft amsl; and the static water level of the deep overburden observation well OW-4D is approximately 950 ft amsl (Figure 16).
- The Saginaw aquifer, consisting of highly fractured and fissile sandstone (frequently described as “soft” or “broken” on well logs) appears be hydraulically connected with discontinuous lenses of glacial sand and gravel near the base of the overburden. Onsite observation well OW-4D and nearby residential wells in the Saginaw aquifer (i.e., 2602 Chapin, 331 Amos) have static water levels in the glacial overburden around 950 ft amsl (Figure 20).
- The Parma sandstone aquifer is hydraulically disconnected from the overlying Saginaw sandstone aquifer by the Saginaw confining unit (primarily shale and limestone). Wells cased into the Saginaw confining unit and open to the Parma sandstone, and lower units, have static water levels near 920 to 930 feet amsl, 20 to 30 feet lower than the Saginaw aquifer. Observation well OW-2s is completed in the Parma sandstone, and instrumented private wells open only to the Parma sandstone include 3141 Sparks and 3213 Perlman (Figure 21). Private wells at 3500 Ann Arbor and 323 Seneca are thought to extend into the Marshall sandstone as well as being open through the Parma. The private well at 429 Dettman is completed in the Parma but cased above the Saginaw confining unit; it is slightly responsive to withdrawals from supply well PW-1, but the response is muted due to flow into the well from the Saginaw sandstone.
- The Marshall sandstone aquifer is hydraulically connected to the Parma sandstone. Where present, the Bayport limestone and Michigan formation may partially impede vertical flow, and the Parma, Bayport, and

Michigan formations are known to have substantially lower transmissivity and storage than the Marshall aquifer. However, high-capacity withdrawals from the Marshall result in observable water level declines in the Parma sandstone. Local static water levels in Parma, Bayport, and Marshall aquifer wells range from 920 to 930 ft amsl. Observation wells OW-2d and OW-3 are completed in the Marshall, as is a private well at 3500 Ann Arbor Road (Figure 22).

Lateral groundwater flow in the overburden and Saginaw aquifers is characteristically different than lateral flow in the Parma, Bayport, and Marshall aquifers (Figure 23). Groundwater in the overburden and Saginaw aquifers tends to flow towards surface water features. Groundwater flow in the Marshall, Bayport, and Parma aquifers is generally south to north, but is significantly deflected by the City of Jackson wellfields.

4.3.4 Aquifer Testing

An aquifer test consisting of two pumping phases and two recovery phases was completed in July 2021 to estimate aquifer parameters. During the test, the datalogging transducers deployed in the supply well, five on-site observation wells, and 11 offsite private wells were programmed to record data at 5-minute intervals. During the first pumping phase, water was withdrawn from supply well PW-1 at an average rate of 1,050 GPM, from 730 AM on July 19 until 730 AM on July 23. The well recovered for 48 hours and was pumped again at 1,388 GPM from 730 AM on July 25, until 730 AM on July 27. During this time, water was used for evaporative cooling or pumped to the onsite 500,000-gallon storage tank; water was not discharged to the ground surface.

A distance-normalized drawdown plot was generated to evaluate data (Figure 24). An abrupt change in slope was observed in data from the first test, suggesting that the City of Jackson significantly reduced background pumping at about 16 hours into the test. A change in slope was not observed during the second pumping phase (July 25-27). The second phase (1,388 GPM for 48 hours) is therefore interpreted as being less affected by background pumping than the first phase (1,050 GPM or 96 hours).

The distance-normalized drawdown data from the second test phase was used to estimate the following aquifer parameters (Table 6):

Table 6: Distance-Normalized Drawdown Analysis

	Radial Distance (feet)	48-hour Drawdown (ft)	Transmissivity (ft^2/d)	Storativity (unitless)
OW-2s	200	10.44	8,500	1.1×10^{-2}
OW-2D	201	15.50	8,500	1.3×10^{-3}
OW-3	505	14.13	8,500	3.8×10^{-4}
3213 Perlman	3609	7.82	8,500	1.1×10^{-4}
3141 Sparks	3405	7.84	8,500	1.3×10^{-4}
3500 Ann Arbor	7020	3.52	8,500	1.7×10^{-4}
323 Seneca	4247	3.05	8,500	5.7×10^{-4}

Additionally, aquifer parameters were evaluated using Thies method (Figures 25a and 25b), with results consistent with the distance-normalized method:

Table 7: Aquifer Parameters Estimated from Theis Method

	Radial Distance (feet)	48-hour Drawdown (ft)	Transmissivity (ft2/d)	Storativity (unitless)
OW-2s	200	10.44	8.5×10^{3}	1.2×10^{-2}
OW-2D	201	15.50	8.6×10^{3}	1.4×10^{-3}
OW-3	505	14.13	9.0×10^{3}	3.5×10^{-4}
3213 Perlman	3609	7.82	8.0×10^{3}	1.5×10^{-4}
3141 Sparks	3405	7.84	8.0×10^{3}	1.7×10^{-4}
3500 Ann Arbor	7020	3.52	9.8×10^{3}	2.1×10^{-4}
323 Seneca	4247	3.05	9.0×10^{3}	7.6×10^{-4}

During both aquifer test phases, drawdown in nearby Saginaw aquifer wells (334 Watts, 2602 Chapin, 3150 Mott, 226 Briscoe, 357 Sheridan) was less than 0.1 feet (Figure 26).

4.4 Hydrogeologic Effects of the Proposed Withdrawal

The information summarized above was used to develop and calibrate a numeric regional groundwater model to illustrate the effects on local aquifers of the both the new proposed withdrawal, and the reduced withdrawal by the City of Jackson. A summary report of the groundwater model is provided as Attachment B.

Specifically, hydrogeologic effects were evaluated with respect to:

- A current “baseline” condition which accounts for the 1.4 MGD withdrawal from JGS well PW-1 since April, along with a 1.4 MGD reduction in water withdrawals by the City of Jackson. The reasoning for the 1.4 MGD reduction in the City of Jackson withdrawal is because from 2016 to 2020, JGS purchased a long-term average of 1.5 MGD from the City; therefore the new 1.4 MGD withdrawal from PW-1 represents 1.4 MGD of water that no longer needs to be purchased from (and withdrawn by) the City. The “baseline” is therefore a 1.4 MGD withdrawal at JGS, and a 5.8 MGD[10] withdrawal distributed evenly between the Mansion Street and Ella Sharp Park wellfields.
- A future “proposed” scenario considering the steady-state effects of an additional 1.36 MGD withdrawal, which when combined with the 1.4 MGD average withdrawal since April 2021, describes the maximum effects at the maximum long-term rate (2.76 MGD). The “proposed” scenario also includes an additional reduction in future water withdrawal by the City of Jackson of 0.68 MGD, or 50% of additional JGS demand, such that a 5.12 MGD withdrawal is distributed evenly between the Mansion Street and Ella Sharp Park wellfields.

The rationale for reducing the City of Jackson’s future withdrawal by only one-half of the proposed 1.36 MGD proposed JGS withdrawal, rather than the full 1.36 MGD, is because the City would likely not be able to commit 1.36 MGD to JGS without increasing their withdrawal. If JGS were to increase their demand by an additional 1.36

[10] The long-term (1998-2020) withdrawal rate for the City of Jackson is approximately 7.0 MGD; however, in the past 6 years (2015-2020), when JGS has operated the facility, the average municipal withdrawal has been 7.25 MGD. For the model, the “baseline” withdrawal rate for the City of Jackson was selected to be 7.2 MGD to reflect both the long-term average, and the slightly higher withdrawal rates in recent years.

MGD in the absence of this permit application, JGS would be purchasing nearly 40% of the City's withdrawal. Because of the seasonality of both the City and JGS water demand, it is expected that the City could meet a portion of the increased demand, but not all of it. The scenario therefore estimates that the City could meet 50% of a new 1.36 MGD demand, but would have to increase their withdrawal rate by another 0.68 MGD to meet the balance.

5.0 SECTION 5: PRIVATE PROPERTY CONTINGENCY PLAN

The groundwater model, aquifer test data, private well hydrographs, and a review of local water well records were used to characterize the effects of the new withdrawal particularly in residential areas east, northeast, and southeast of JGS, where most private wells are located. Based on the analysis, CEC has prepared and committed to a private property contingency plan in the event that well interference complaints are received from the local community. The plan is provided as Attachment C.

6.0 SECTION 6: ENVIRONMENTALLY SOUND AND ECONOMICALLY FEASIBLE WATER USE CONSERVATION MEASURES

CEC self-certifies that environmentally sound and economically feasible water conservation measures developed for Michigan's Electric Utility Sector[11] have been adopted at JGS and throughout the CEC generation portfolio. Measures to promote water efficiency and conservation at JGS are outlined in Section 7, Subsection (3) below.

7.0 SECTION 7: DECISION-MAKING STANDARDS OF THE GREAT LAKES – ST. LAWRENCE RIVER BASIN WATER RESOURCES COMPACT

In accordance with the Great Lakes – St. Lawrence River Basin Water Resources Compact, CEC's proposed withdrawal will be implemented such that the following criteria are met:

3) All water withdrawn shall be returned, either naturally or after use, to the source watershed less an allowance for consumptive use;

The proposed JGS withdrawal and the City of Jackson wellfields are located within the Upper Grand River watershed, a tributary to Lake Michigan.

The consumptive use is approximately 83%, and 17% of the water used is returned to the Upper Grand River basin via permitted discharge to the sanitary sewer and the City of Jackson WWTP. Following implementation of the withdrawal, the ratio of consumptive use to return flow is expected to remain the same. All water withdrawn, less the consumptive use, will therefore be returned to the source watershed, which is the Grand River.

4) The withdrawal will be implemented so as to ensure it will not result in significant individual or cumulative adverse impacts to the quantity or quality of the waters and water dependent natural resources of the source watershed and the Great Lakes;

Sections 4.3 and 4.4 describe the hydrologic effects of the proposed withdrawal. The source aquifer is a regional confined aquifer extensively used for water supply. The proposed withdrawal effectively relocates the point of withdrawal from the City wellfields to the JGS. No impairment of the quantity or quality of waters or water-dependent natural resources is predicted to occur as a result of the proposed withdrawal. Specifically:

[11] Water Conservation Plan – Electric Utilities Sector Plan (2008). Barr Engineering Company.

- The Marshall aquifer, from which groundwater is proposed to be withdrawn, is a regional confined aquifer. The City of Jackson has withdrawn an average of 7 MGD of groundwater from the Marshall aquifer for at least the past 22 years. CEC purchased about 21% of the treated municipal supply from 2016 to 2020, with a maximum monthly purchase of 3.78 MGD in August 2016. The original development agreement was written with the understanding that the facility would purchase approximately 3.2 MGD on average, and up to 5.4 MGD as a maximum daily demand.
- There is no evidence that the Marshall aquifer is hydraulically connected to the Grand River, wetlands, or other surface water feature in the vicinity of the JGS. There is no evidence that the City of Jackson municipal withdrawals from the Marshall aquifer are connected to the Grand River, wetlands, or other surface water features.
- The Marshall aquifer discharges to the Michigan Lowlands (Ottawa County) and Saginaw Lowlands (Bay County) over 100 miles from the site. The withdrawal is not expected to measurably affect groundwater discharge rates.
- Approximately one-sixth of the withdrawal will be returned to the Grand River through the City of Jackson WWTP, with the balance being evaporated. Based on August 2018 – July 2021 invoices, the average return flow from JGS is 178 GPM, which is discharged by the City of Jackson WWTP to the Grand River (0.33% of the 52,317 GPM base flow, Grand River at Jackson). The discharge meets permitted quality standards. The return flow is expected to increase as the water use is expected to increase, but the increased treated discharge through the WWTP is not expected to measurably affect water quality or quantity in the Grand River.

5) The withdrawal will be implemented so as to incorporate Environmentally Sound and Economically Feasible Water Conservation Measures;

The proposed withdrawal is to be implemented in the context of existing and new water conservation measures.

Site Specific Conservation Measures:

Water and natural gas are the two primary operational expenses at JGS. Water conservation is a high priority at JGS, because the invoiced water rates paid to the City of Jackson strongly affect whether or not JGS can competitively generate electricity.

To conserve water specifically at JGS, routine activities include:

- Conducting daily rounds identifying water leaks needing maintenance.
- Periodic inspection and cleaning of the steam turbine condenser to improve both efficiency and condensate capture.
- Condensed steam is sent to a deaerator which is then re-used in the Heat Recovery Steam Generator (HRSG) process.

Additionally, several major infrastructure water-use reduction projects that have been implemented at the JGS to improve water conservation and reduce water costs include:

- Capturing boiler blowdown from the HRSG as well as condensate from the turbine air filter systems which are routed for reuse in the cooling towers.

- Installation of Variable Frequency Drives (VFD) on 10 cooling tower fan motors to allow for slow starts and modulating speeds. The automated control of fans results in tighter temperature control resulting in less make-up water and energy usage.
- Water treatment and cooling tower chemistry is optimized in order to maintain appropriate cycles of concentration and chemistry within the system.

In conjunction with proposed withdrawal, JGS will be installing green sand filters to purify well water prior to use in the JGS reverse osmosis system. As part of filter use, the system will require a periodic backflush. To conserve water and reuse as much as possible, the site studied the backflush events and determined that approximately one-half of the backflush discharge can be reused in the site's cooling tower, equating to approximately 50,000 gallons during each backflush event. The use of green sand filters will therefore significantly reduce the backflush volume discharged to the City POTW and the Grand River.

Consumers Energy Conservation Measures:

In 2018 CEC committed to a 5-year breakthrough target of reducing water usage by one billion gallons. This target is intended to drive progress towards a company-wide culture change around water stewardship, enabling the entire company to get involved to reduce the environmental impact of operations and see opportunities and benefits of analyzing water risk activities.

Company-wide efforts put in place to improve water stewardship include: reuse or recycle options for projects with water requirements, and management of water-intensive systems with efforts to reduce run time of such equipment where possible. Since 2018, CEC has reduced water use by more than 800 million gallons by:

- Collecting and reusing water that runs off coal piles at power plants.
- Collecting and reusing thermal wastewater within power plants air pollution control device.
- Reducing the amount of water used to safely handle and move residuals created by combusting coal.
- Developing a new process to reuse and save water while drilling to replace and install new pipes.

Statewide, the JGS project is a key component of CEC's Clean Energy Plan that not only retires coal generation facilities years ahead of schedule, but in the process eliminates water use at two facilities that are currently the third and seventh largest water uses in Michigan. In 2020,

- The JH Campbell Plant in West Olive, Ottawa County, used 223 billion gallons of water, including 400 million gallons of groundwater;
- The DE Karn Plant in Hampton Township, Bay County, used 84 billion gallons of water.

The retirement of Karn is currently scheduled for 2023, and JH Campbell is planned for retirement in 2025 pending approval of CEC's Integrated Resource Plan (IRP). Additionally, CEC has also retired the Cobb, Whiting, and Weadock facilities since 2016. In 2015, the final full year in which these facilities operated,

- The BC Cobb Plant in Muskegon used 84 billion gallons of water;
- JR Whiting Plant in Luna Pier used 77 billion gallons of water;

- The Weadock Plant in Hampton Township used about 86 billion gallons of water[12].

In total, CEC has reduced or plans to reduce about 554 billion gallons per year of water use across the State of Michigan through the retirement of coal plants. The retirements of these plants ***collectively reduces water use by the entire State of Michigan by nearly 19% (based on 2015 usage).***

6) The withdrawal or consumptive use will be implemented so as to ensure that it is in compliance with all applicable municipal, State and federal laws as well as regional interstate and international agreements, including the Boundary Waters Treaty of 1909;

The project has been developed and remains in compliance with existing laws.

CEC obtained approval for supply well PW-1 from the Jackson County Health Department on January 28, 2020. CEC obtained permit approval for the tank, piping, and treatment infrastructure from Blackman Township in the summer of 2020. CEC registered supply well PW-1 for a maximum withdrawal rate of 2 MGD on March 15, 2021 (Attachment A-2).

The Boundary Waters Treaty of 1909 was agreed to by the United States and Canada to provide a mechanism for the resolution of disputes over water bordering the two countries and to ensure the waters of the Great Lakes remain navigable. The United States and Canada share no border on Lake Michigan (the Great Lakes watershed in which the withdrawal will take place); additionally, no structures or potential impediments to navigation will be installed within a Great Lake as a part of the proposed withdrawal. There will be no violation of the Boundary Waters Treaty of 1909 as a result of the proposed withdrawal.

By virtue of compliance with the provisions of Part 327, the proposed withdrawal will comply with the Great Lakes-St. Lawrence River Basin Water Resources Compact. See MCL 324.32730(c).

7) The proposed use is reasonable under common law principles of water law in Michigan, based upon a consideration of the following factors:

a. Whether the proposed withdrawal is planned in a fashion that provides for efficient use of the water, and will avoid or minimize the waste of water;

Section 7, subsection 3 details several areas in which CEC has implemented or planned for efficient use of water, and minimized the waste of water, both corporately and specific to JGS. The viability of the JGS is also a critical component of CEC's 2021 Clean Energy Plan, accelerating the timeline to end coal use by 15 years, which will reduce statewide water consumption by approximately 19%.

Additionally, the proposed withdrawal reduces water waste for the City of Jackson. JGS does not need potable, disinfected water to cool its turbines. The proposed self-supply of groundwater for cooling and plant use is a more efficient use of water than the current purchase of potable quality water for a non-potable use. By accessing water at the site, JGS would greatly reduce the energy and expense related to pumping, storing, treating, and distributing water from the City of Jackson treatment plant to the JGS.

[12] Combined water use for the Karn-Weadock facility is reported by EGLE. Weadock use is estimated as the difference between total 2015 use (174 billion gallons) and average Karn use (88 billion gallons) in the four years of reporting since Weadock was retired (2017-2020).

b. If the proposal is for an increased withdrawal, whether efficient use is made of existing water supplies;

The proposal is for an increased withdrawal relative to the 2 MGD previously registered to supply well PW-1.

The efficient use of water has already been critical to the economic viability of JGS and impacts whether the plant can competitively generate electricity to the grid. Measures to ensure water efficiency at JGS and to promote water conservation across the company are outlined in in Section 7, Subsection (3) above.

c. The balance between economic development, social development and environmental protection of the proposed withdrawal and use and other existing or planned withdrawals and water uses sharing the water source;

i. Economic Development

JGS was developed by Kinder Morgan in 2002 as part of an economic development agreement with the City of Jackson on the former Goodyear manufacturing site. Kinder Morgan agreed to purchase water from the City of Jackson for a minimum of 10 years from the start of operations, at tiered water rates prescribed by the agreement, after which they had the prerogative to develop an alternate supply. The agreement transferred to CEC with the sale of the plant, although the 10-year requirement had already been satisfied. The agreement anticipated that the facility would have an average daily water demand of 3.2 MGD, with a single-day maximum demand of 5.4 MGD, which is greater than the withdrawal rates being proposed in this Application.

The original agreement was based on a tiered rate system, which was replaced in 2019. As a result, water rates increased from $1.35 per 100 cubic feet of water (plus service charges) to $3.73 per 100 cubic feet in 2021, rising to $4.18 in 2022. The rate is expected to continue to increase. The rapid rise and future unpredictability of water rates diminish the viability of running the plant, which in turn is critical to achieving the 2021 Clean Energy Plan goals of retiring the coal baseload portfolio.

Impact on City Revenues

The self-supply of water at JGS will reduce revenue to the City. Historically purchasing about 21% of the municipal supply, a reduced water purchase by CEC will reduce City revenues, but the lost revenue will be partially offset through a reduction in the water volume withdrawn at the wellfields, treated to potable standards, and delivered to JGS. Additionally, JGS is not fully eliminating municipal water use but will continue to purchase potable water for employee and sanitation needs; for emergency use; and for supplemental supplies when monthly demand approaches a permitted maximum. Consumers will continue to pay the City of Jackson readiness charge. The City will continue to realize wastewater revenues, also expected to increase proportionally if JGS water use increases.

Table 8 summarizes the total volume purchased and the total invoices for the past three calendar years:

Table 8: Water Usage and City of Jackson Invoices (2018-2020)

	JGS Water Usage (gallons)	Annual Invoice from City of Jackson
2018	572,198,682	$1,051,946
2019	589,349,940	$1,319,784
2020	519,959,297	$2,301,526

Increased tax revenues to the City of Jackson, Blackman Township, and Summit Township will also partially offset reduced water revenues. Capital improvements associated with the project include:

- $4.1 million – new well, tanks, pumps, conveyance, and associated buildings and equipment
- $600,000 – 2 new wells
- $7 million – water treatment system

Finally, if JGS were to experience greatly reduced operations, the plant would use significantly less water and generate significantly less water revenue for the City. A closed plant would generate no water or tax revenues.

The bottom line is that the proposed project will reduce invoiced water revenues to the City, but the City's expenses to pump, treat, and convey water will also be reduced, and the City and other municipal governments will realize increased tax revenue.

Impact of Water Rates on JGS Power Production

A third economic consideration is that the proposed project is essential to hold electricity rates low, saving money to rate-payers in the Jackson community as well as to the City of Jackson.

JGS is dispatched into the utility generation market (dispatch rate) based on many factors, the most important being the cost per megawatt-hour (MWh) to rate payers. Both the cost of purchasing city water for plant processes, and the length of time the plant is able to run, are variables in the models that determine the JGS dispatch rate, which in turn affects the operational costs and ultimately the costs passed along to rate payers.

In 2019, CEC completed an upgrade of the JGS generating station by increasing stack heights, allowing JGS to be dispatched more often. Based on the stack height increase, site production (in MWh) was projected to increase by 20% to 22%; the longer run times lead to overall efficiency improvements. However, based on the projected increase in city water rates, the JGS generation units would instead become less competitive in the market, ultimately reducing the site's electric production by approximately 20%, possibly as much as 27%.

The impact of the reduced JGS production, as a result of increased water rates, is that instead of saving rate payers $1.5 million by increasing run-times by 20% to 22%, as a result of site improvements, the water rates cost rate payers an additional $5 million (to as much as $8 million per year) due to increased water costs (approximately $3M) and loss of economic dispatch (approximately $2M) resulting in purchasing power off the grid at higher market prices.

ii. Social Development

As outlined above, JGS is an important generation asset in the City of Jackson and Jackson County. Its continued viability is important to the regional economic fabric.

CEC is a major employer in the City of Jackson and Jackson County with 2,500 employees as of 2020 in Jackson County, providing a significant tax base for the City and County. In 2020, CEC paid $9.7M to Jackson County in real and personal property taxes for Jackson County facilities.

Since 2017, CEC has spent $2.07 billion (approximately $440 million per year) on vendors in zip codes 49201, 49202 and 49204 (City of Jackson and Blackman Township).

In the past 5 years, (since 2017), CEC and the Consumers Energy Foundation, including employees and retirees, have contributed a total of $5.9M to organizations in the City of Jackson, including:

- Jackson YMCA
- United Way
- City of Jackson Marketplace Food Festival Kitchen
- Enterprise Group (annual support, Lean Rocket Lab startup, COVID economic development assistance and Our Town)
- Anchor Initiative (annual support)
- Jackson DDA (Our Town)
- Jackson Young Professionals (Bright Walls)
- Jackson Community Foundation (COVID and other assorted programs)
- Community Action Agency (walk for warmth)
- Great Start Collaborative (early literacy)
- Jackson Symphony Orchestra & Guild (annual support)

Additionally, CEC supports the following organizations annually through event sponsorships, volunteer grants, and matching gifts:

- Jackson Interfaith Shelter
- Jackson Friendly Home
- AWARE Shelter
- The Salvation Army
- HF Allegiance Health
- Jackson County Chamber of Commerce
- Jackson High School
- Jackson Pride Center
- NAACP
- Habitat for Humanity
- Jackson Community Food Pantry
- Immanuel Lutheran Food Pantry
- Queens Food Pantry
- St. Vincent DePaul Food Pantry
- First Congregational Church Food Pantry
- St. Mary’s School
- St. John School
- Big Brothers Big Sisters
- John George Home
- City of Jackson Parks & Rec Dept

CEC has long been a committed corporate member to the City of Jackson and the Jackson County communities. JGS is an integral part of CEC's investment in Jackson, and its viability as part of the generation portfolio remains central to CEC's business and community initiatives.

iii. Environmental Protection Considerations.

As part of the Part 327 permit application process, CEC has determined there will be no individual or cumulative resource impacts resulting from the proposed increased withdrawal. As discussed in Section 4, surface waters, wetlands, and other nearby users of groundwater will not be impaired by the proposed withdrawal. There is no evidence that the JGS withdrawal has any effect on the hydrology of the Grand River and associated wetlands, as well as the wetland adjacent to the JGS property.

iv. Other Existing or Planned Withdrawals and Water Users Sharing the Water Source.

Consumers Energy has entered into agreements with the owners of 11 water wells on nearby properties to understand in-well drawdown of private wells. Seven months of pumping from the JGS supply well PW-1, at a long-term average rate of 1.4 MGD, has resulted in no well interference complaints from nearby residents and businesses.

Existing nearby users of hydrologically connected waters are identified in Section 5, specifically Attachment C, which reviews the potential risks to nearby water users, the geographic distribution of those risks, and the proposed mitigation strategy should well conflicts be observed. As discussed in Attachment C, it is not possible to evaluate every potential well conflict in advance, because water well records exist for only about one-third of nearby properties; and because well construction, pumping equipment, pumping depth, equipment age and deterioration, and usage pattern varies at every private supply. In these residential neighborhoods generally 40 years old, it should be expected that many wells, pumps, and pressure tanks could be approaching the end of their useful life. CEC understands that even a small change in static water level may cause one well pump to fail; while a nearby well with its pump submerged in 30 feet of water is unlikely to be affected by 20 feet of drawdown related to a new withdrawal.

The goals of the proposed mitigation plan are to:

- Describe and document CEC's responsibilities to the community
- Map the chains of communication and responsibility for responding to any real or perceived interference
- Document the funding mechanisms available for responding to interference complaints.

CEC cannot guarantee that there will not be a well interference complaint or evaluate the risks to every individual well. However, CEC has identified the areas in which interference could be most likely to occur.

The City of Jackson municipal supply, specifically the Mansion Street wellfield, will be favorably impacted by the proposed withdrawal as its withdrawal rate will be reduced and groundwater levels expected to rise.

Only two nearby commercial businesses were determined to have wells that draw water from the Marshall formation. MECA Associates (Michigan Tool and Die, 205 Watts Rd) was contacted by CEC and reported that their well is sealed and that they purchase water from the City of Jackson. Maurer's car wash (3500 Ann Arbor

Road) has two wells in the Marshall sandstone, and one of the two is instrumented with a datalogging transducer as part of this hydrogeologic evaluation. Maurer's car wash also purchases water from the City.

d. The supply potential of the water source, considering quantity, quality, and reliability and safe yield of hydrologically interconnected water sources;

The Marshall aquifer is a prolific bedrock aquifer utilized for the City of Jackson and nearby industrial supplies and is capable of supporting the proposed JGS withdrawal.

As discussed in Section 4.3.1, the approximate drawdown at JGS well PW-1 at the maximum proposed withdrawal rate (2.5 MGD) is 35.4 feet, or 90 feet (881.6 ft amsl) below the top of casing. The pump intake is currently set at 130 feet (841.6 ft amsl) below top of casing. Additionally, if a second production well at the nearer of the two proposed locations (approximately 500 feet south, near the location of observation well OW-3) were to be pumped at 2.5 MGD at the same time as PW-1, and that the aquifer at the second well location has similar properties as at PW-1, the second well would result in approximately 8.05 ft of drawdown per MGD at PW-1, or 20.1 additional feet of drawdown[13] (Figure 18).

The new withdrawal is not expected to influence the quality, quantity, or safe yield of the City of Jackson's wellfields, as the City wellfields will pump less due to JGS developing a site supply. The reduced withdrawal from the City of Jackson's wellfields therefore increases their safe yield and reliability. The new withdrawal is not expected to significantly affect water quality of the City of Jackson wells, as the orientation and width of the City wellfield capture zones are not significantly changed by the new withdrawal (Figure 27).

According to planning documents, the service population and water demands for the City of Jackson are projected to further decline through at least 2035, based on the City of Jackson Draft Drinking Water State Revolving Fund Project Plan (2021)[4].

e. The probable degree and duration of any adverse resource impacts caused or expected to be caused by the proposed withdrawal under foreseeable conditions, to other lawful consumptive or non-consumptive uses of water or to the quantity or quality of the waters and water dependent natural resources of the Basin, and the proposed plans and arrangements for avoidance or mitigation of such impacts; and,

The proposed withdrawal is not expected to result in, or contribute to, adverse resource impacts.

No well conflicts have occurred to date, based on six months of operating PW-1 at a rate of 1.4 MGD. Attachment C presents CEC's proposed arrangements and mitigation plan for addressing well interference complaints.

f. Consideration as to the need for the proposal to include restoration of hydrologic conditions and functions of the source watershed

There is no basis on which to identify any hydrologic conditions and functions that will require restoration.

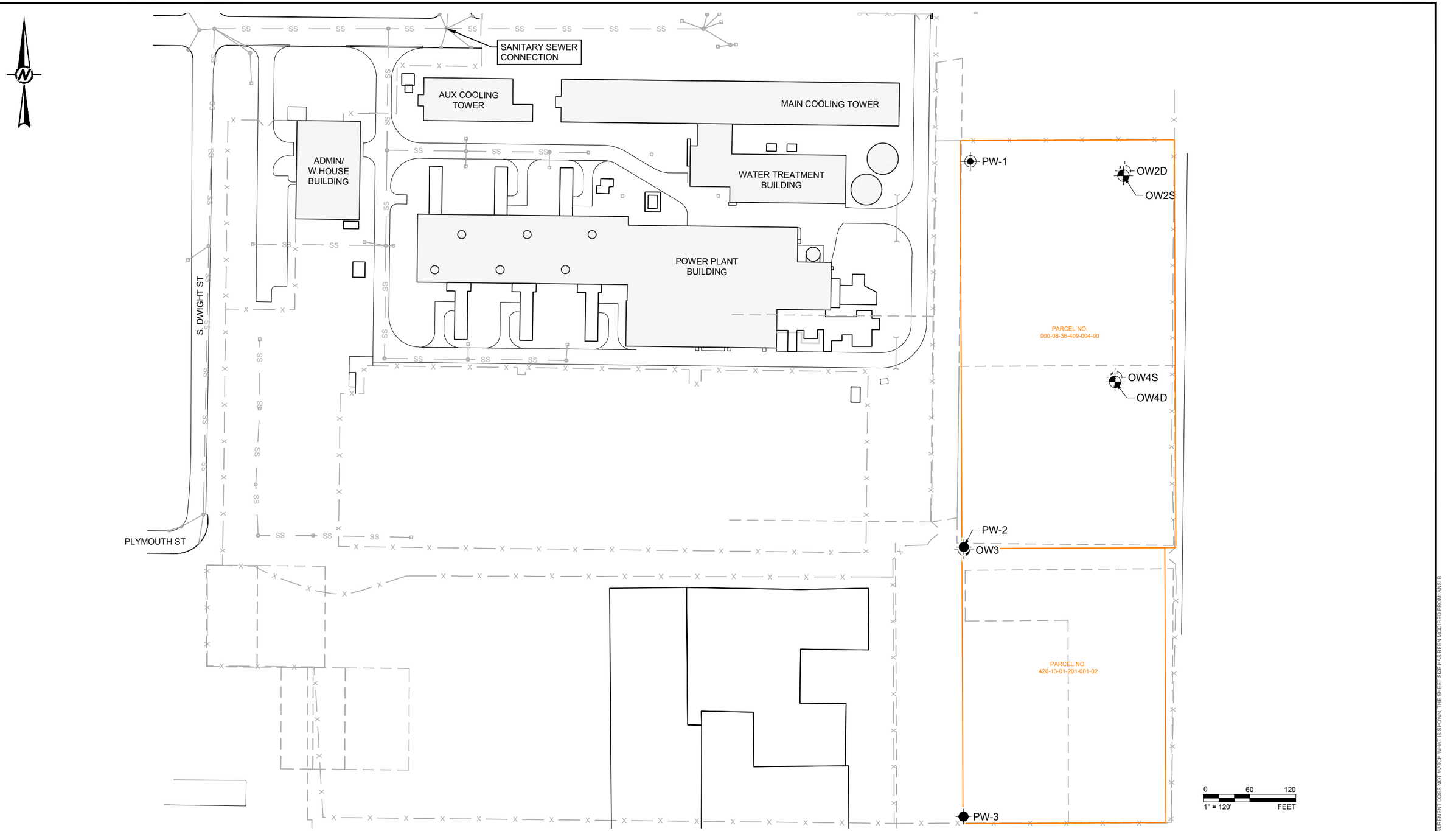
[13] The influence of well PW-1 at the location of a new proposed supply well (approximately near observation well OW-3, 500 feet south of PW-1) is approximately identical to the influence that the proposed well would have at PW-1, provided that aquifer parameters do not significantly change between locations.

8.0 SECTION 8: DOES THIS FACILITY HOLD A PERMIT ISSUED UNDER PART 31 FOR A COOLING WATER INTAKE STRUCTURE?

No.

9.0 PERMIT APPLICATION AND RETURN PAYMENT

A $2000 check made payable to the State of Michigan is enclosed. Please let us know if you have any questions or need additional information to confirm that the permit application is administratively complete. We look forward to a favorable review and issuance of a Part 327 permit for the proposed water withdrawal.



LEGEND

PW	PRODUCTION WELL
PW	PROPOSED PRODUCTION WELL
OW	OBSERVATION WELL

REFERENCE

BASE MAP TAKEN FROM CONSUMERS ENERGY ALTA/ACSM SURVEY, DATED 06-18-2014; DRAWING NO. SG-21492.

CLIENT
CONSUMERS ENERGY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-29
DESIGNED	JH
PREPARED	DJC
REVIEWED	
APPROVED	

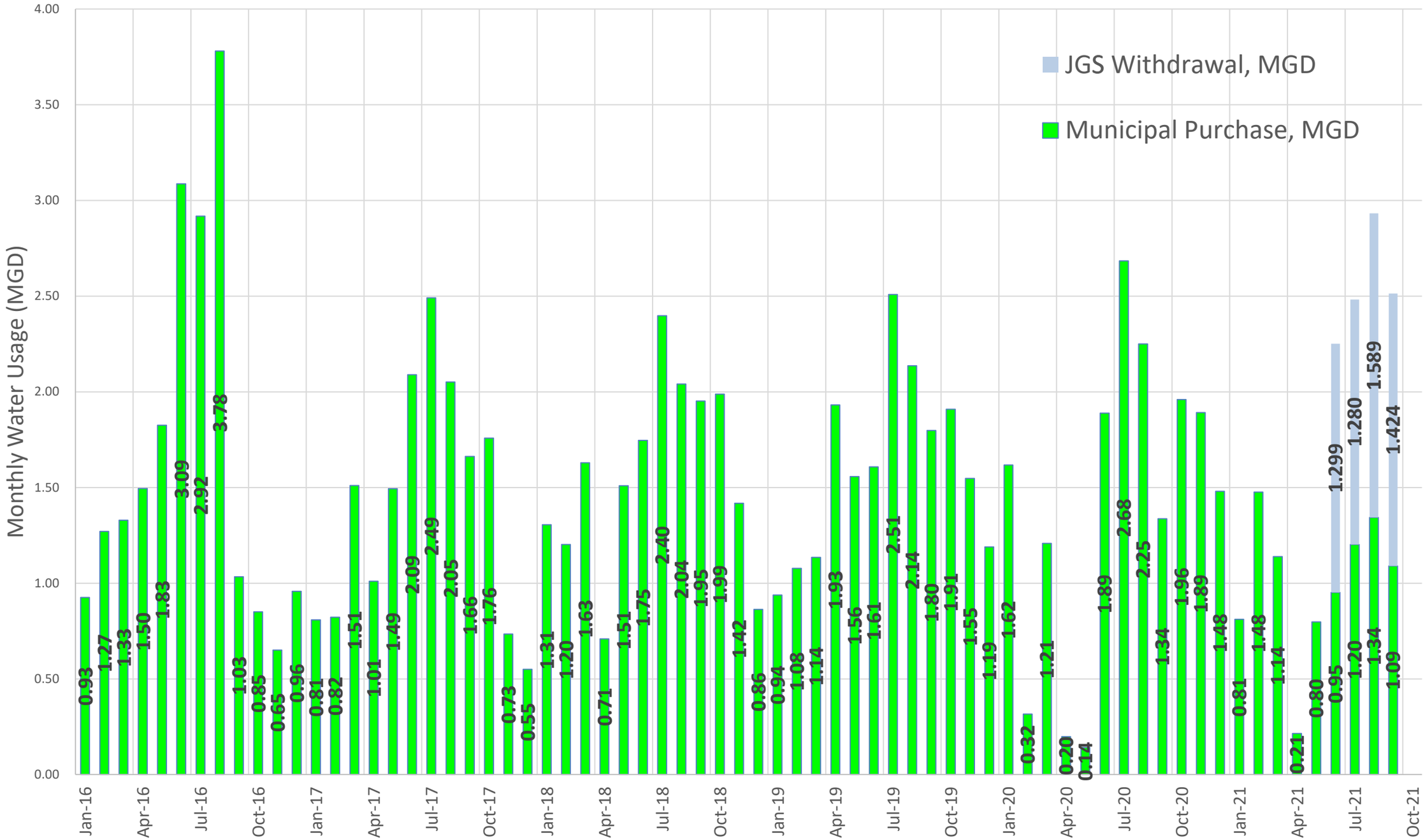
TITLE
PRODUCTION WELL AND OBSERVATION WELL LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
19131361	19131361A001.dwg	0	1

Monthly Average Water Usage, Jackson Generating Station

Consumers Energy Company

January 2016 - September 2021



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	JW
APPROVED	MW

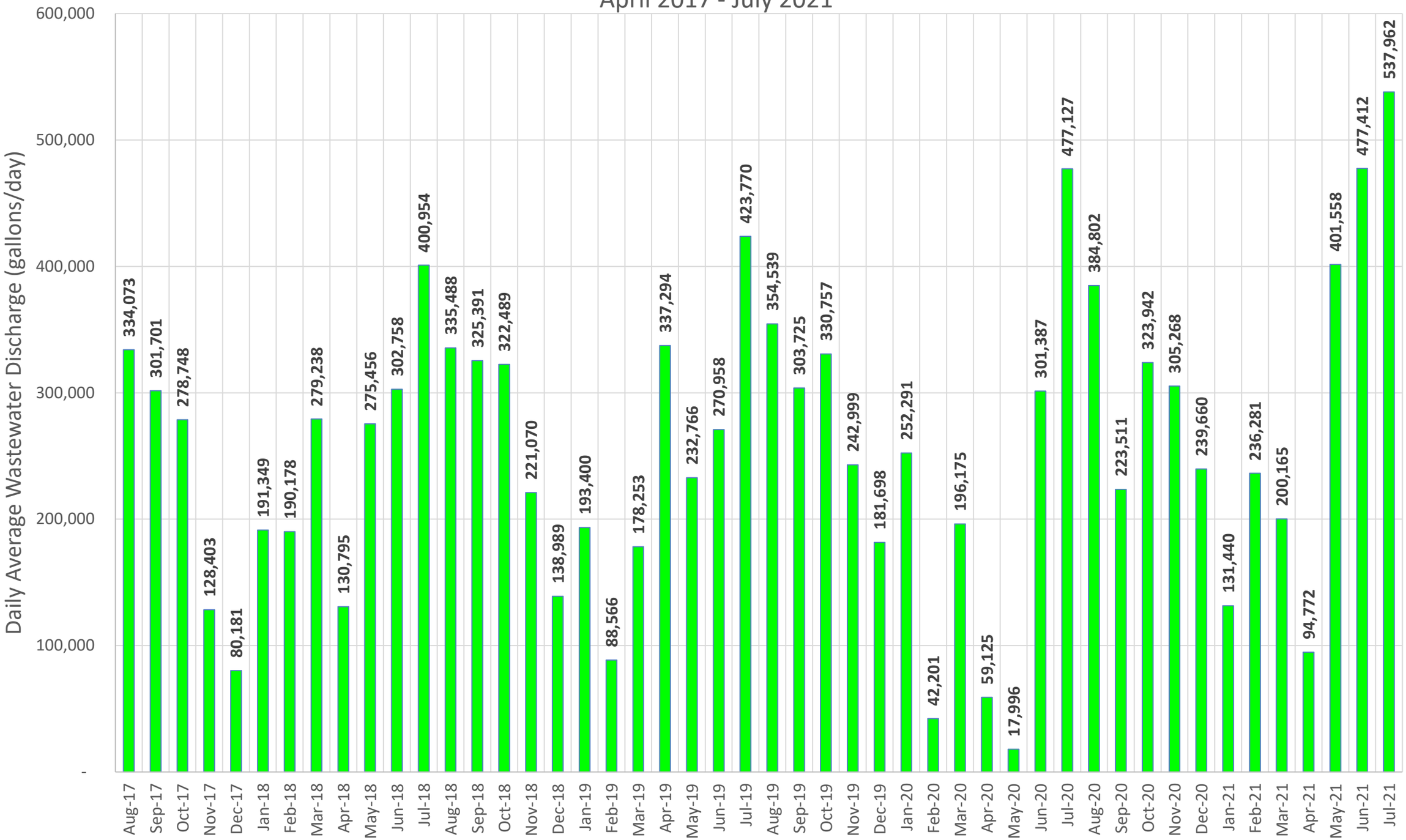
TITLE
MONTHLY AVERAGE WATER USE
MILLION GALLONS PER DAY (MGD)
JANUARY 2016 – SEPTEMBER 2021

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 2

Monthly Wastewater Discharge, Jackson Generating Station

Consumers Energy Company

April 2017 - July 2021



CLIENT
CONSUMERS ENERGY COMPANY

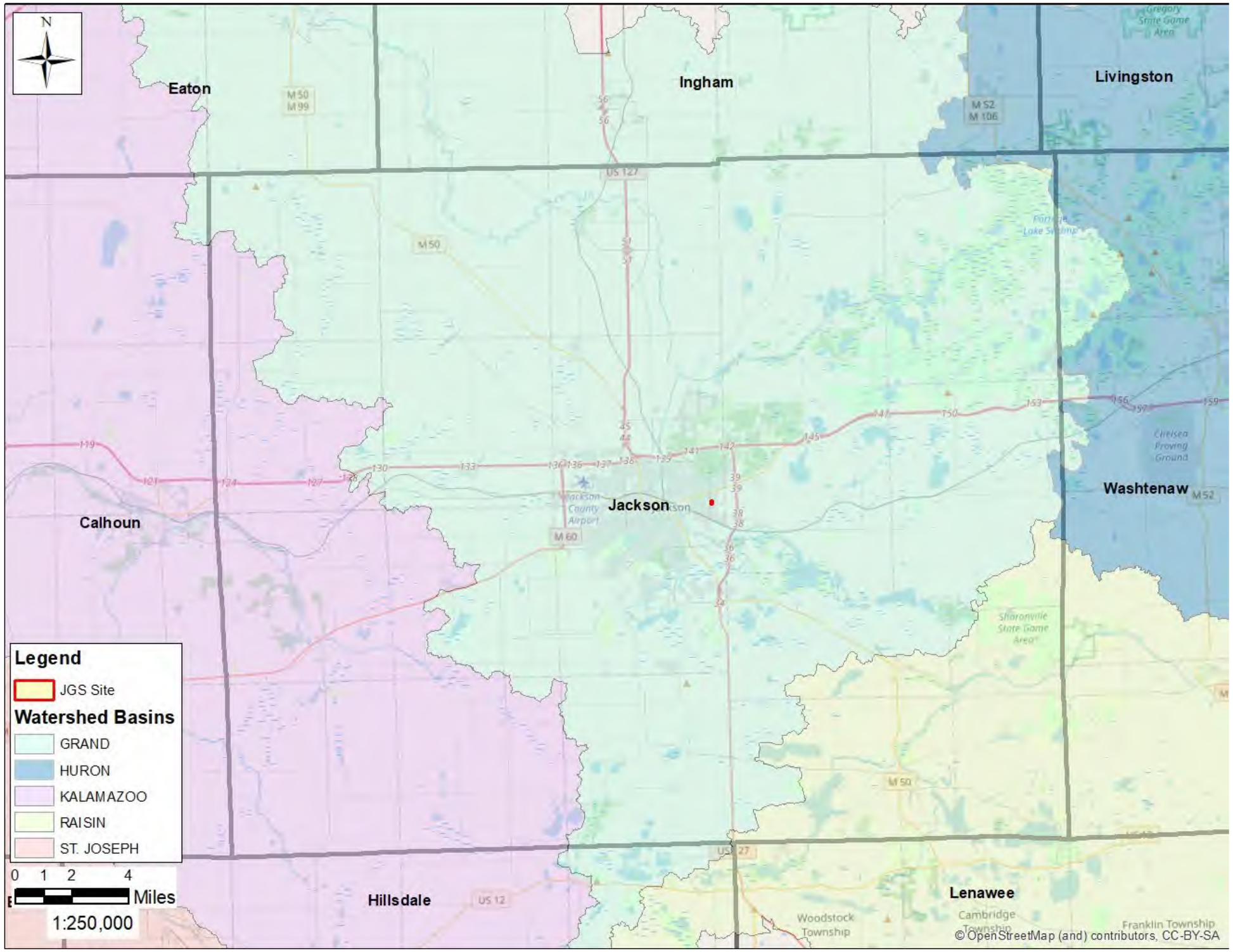
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	JW
APPROVED	MW

TITLE
MONTHLY WASTEWATER DISCHARGE
(GALLONS PER DAY)

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 3



CLIENT
CONSUMERS ENERGY COMPANY

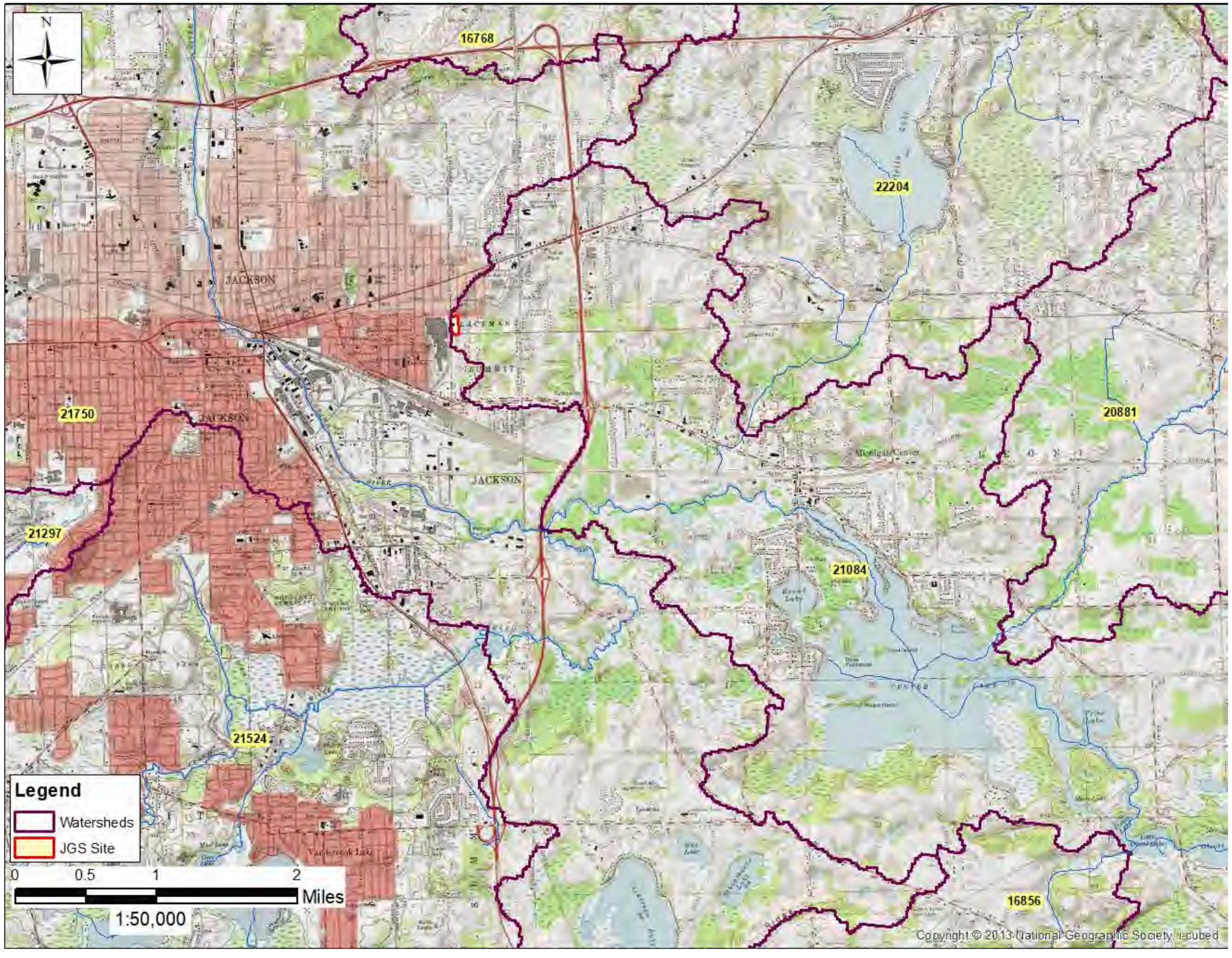
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	JW
APPROVED	MW

TITLE
REGIONAL WATERSHED CATCHMENTS

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 4



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

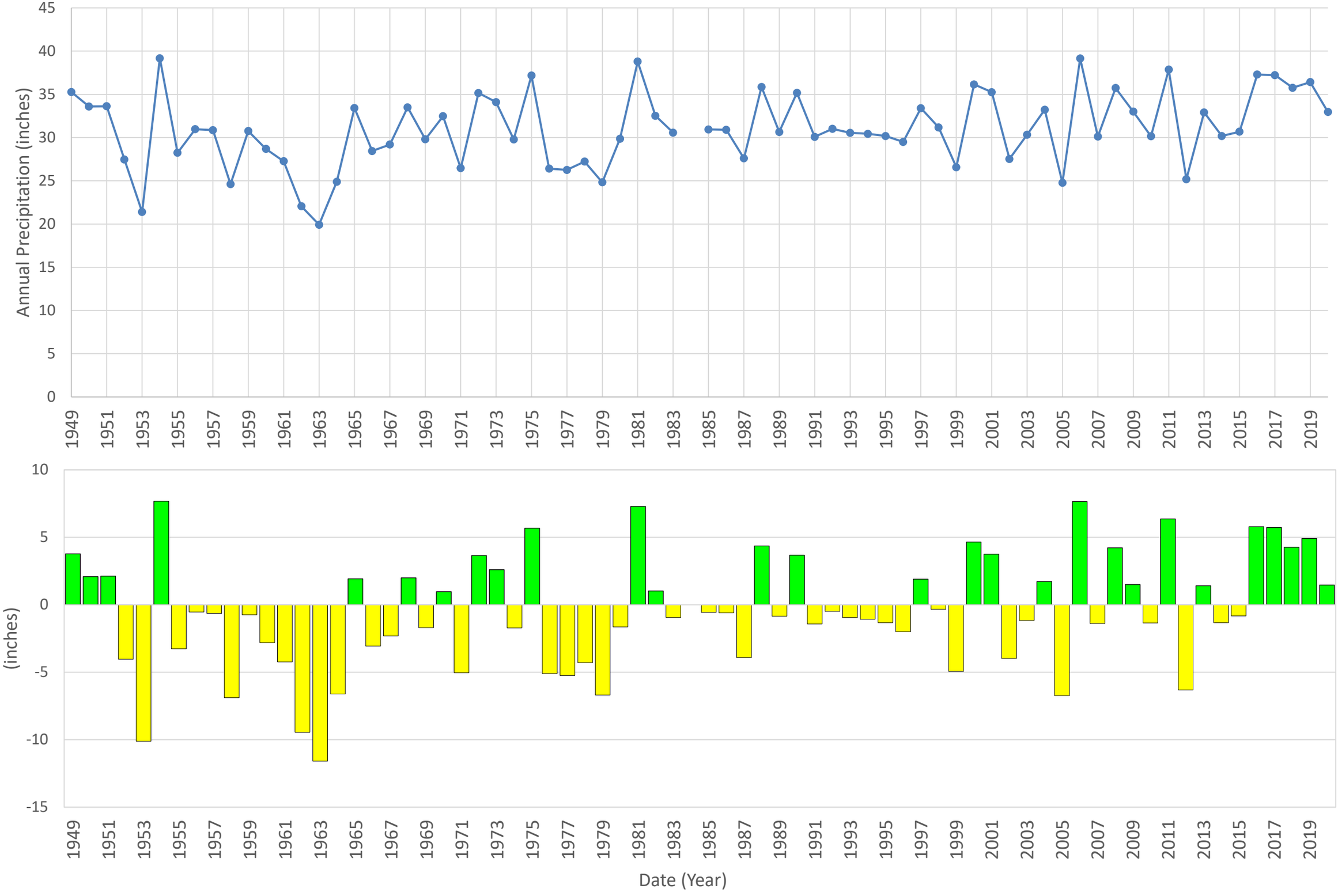
TITLE
LOCAL WATERSHED CATCHMENTS

PROJECT NO. 19131361

REV. 5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm



Note: 1980-2010 Normal: 31.50 inches

CLIENT
CONSUMERS ENERGY COMPANY

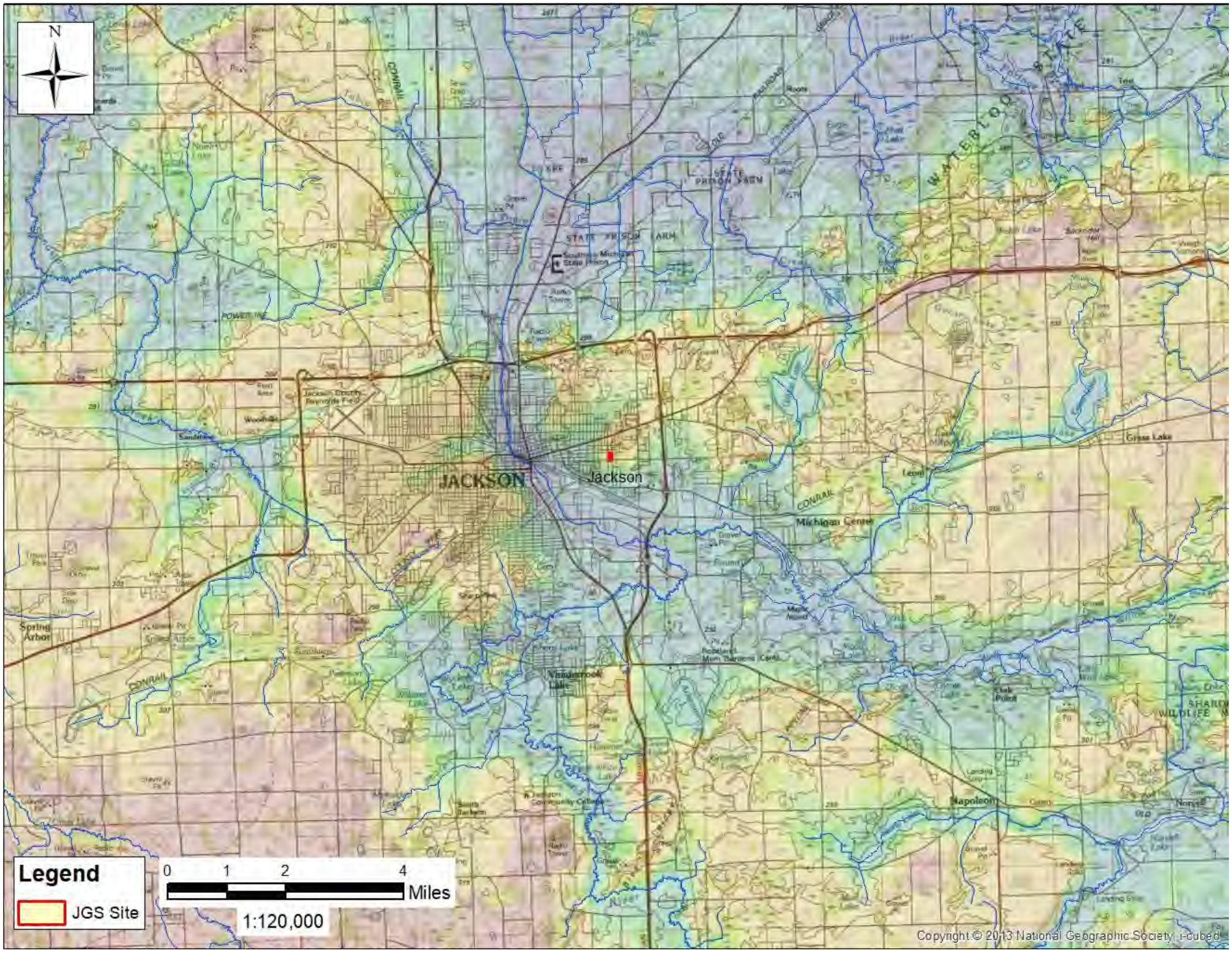
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
ANNUAL PRECIPITATION TRENDS
JACKSON REYNOLDS FIELD, USW00014833

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 6



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

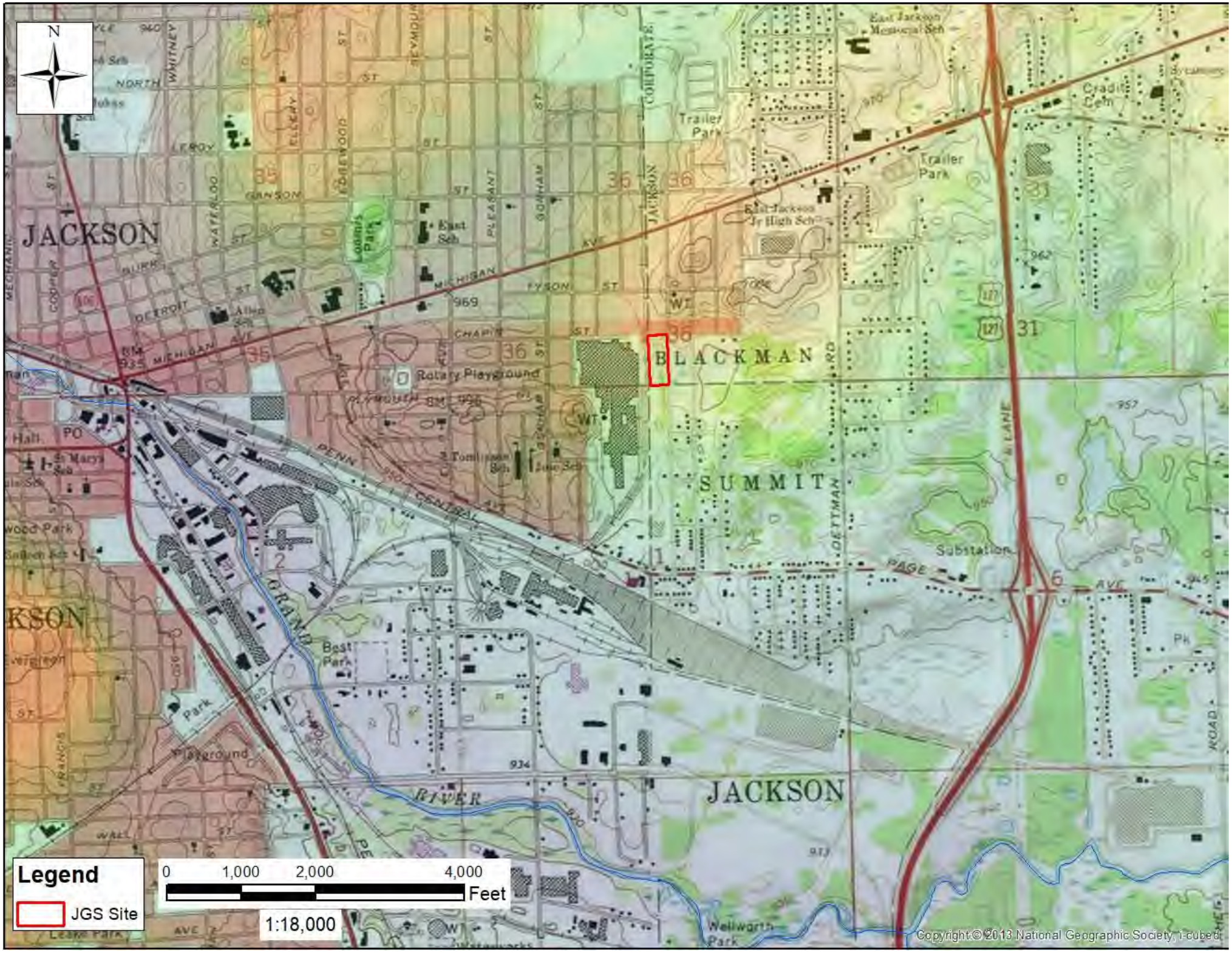
TITLE
REGIONAL TOPOGRAPHY

PROJECT NO. 19131361

REV.

7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm
0



CLIENT
CONSUMERS ENERGY COMPANY

CONSULTANT
GOLDER

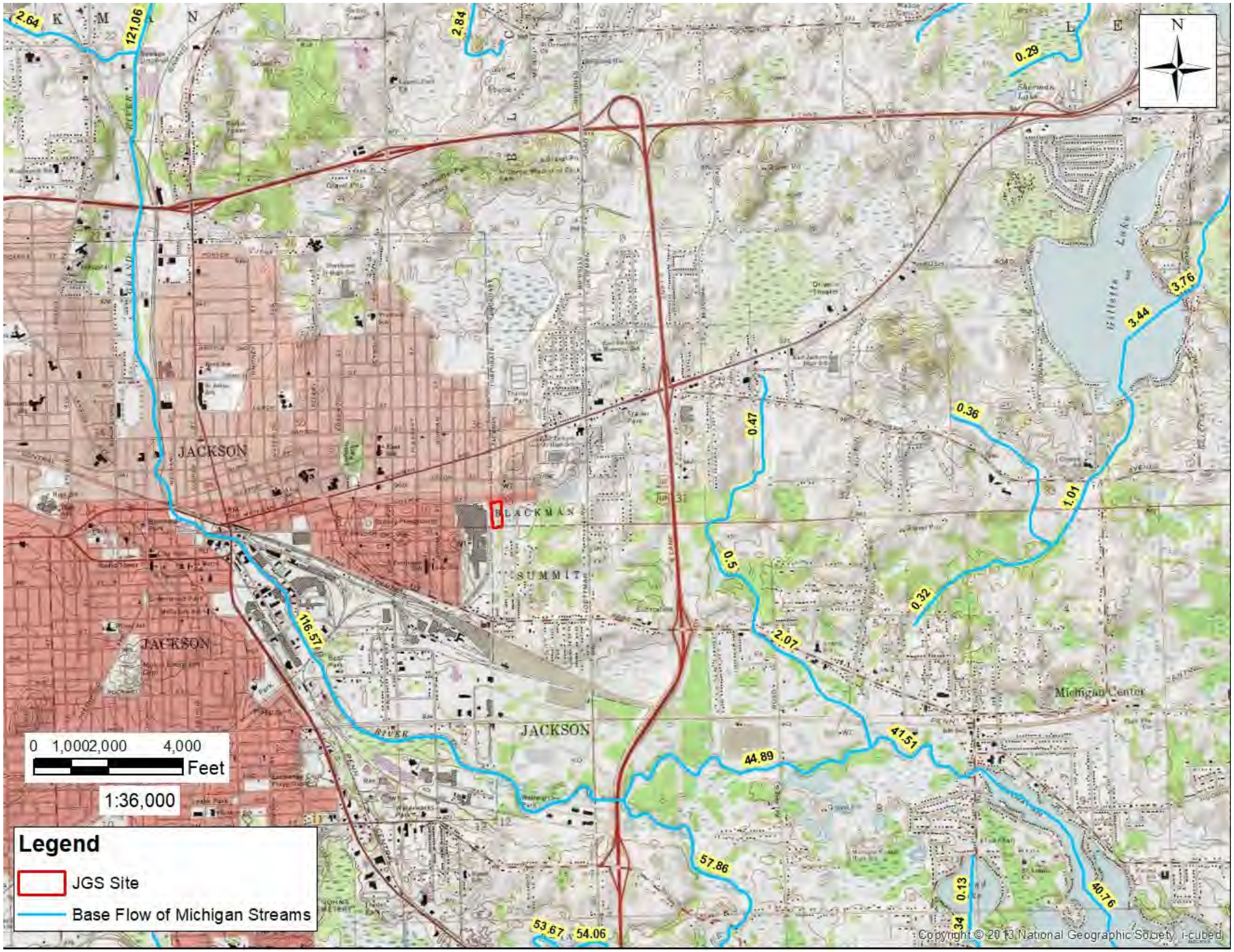
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
LOCAL TOPOGRAPHY

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



Base flow units – cubic feet per second (cfs)
1 cfs = 448.8 GPM

CLIENT
CONSUMERS ENERGY COMPANY

CONSULTANT
GOLDER

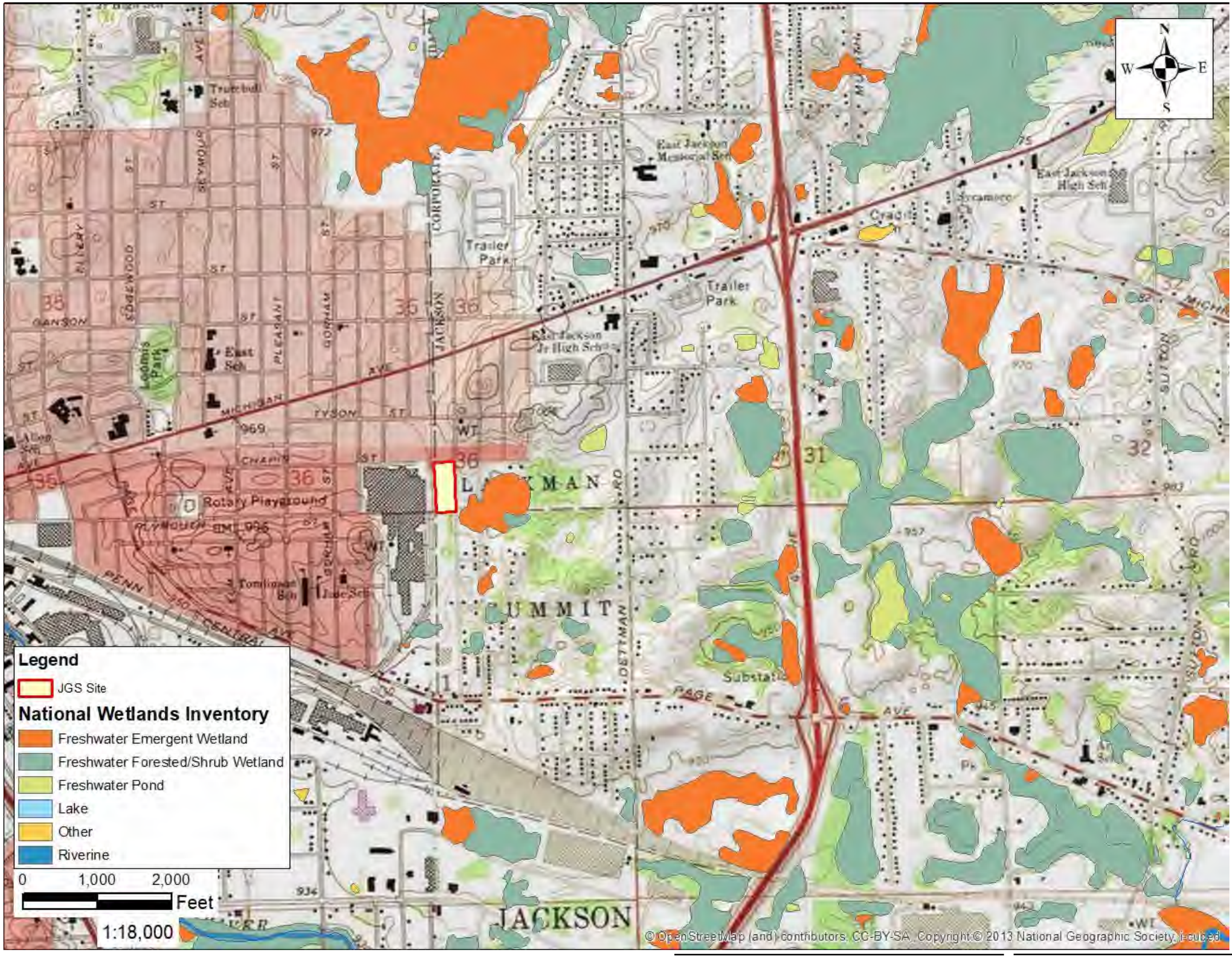
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SURFACE WATER BASE FLOWS

PROJECT NO.	CONTROL	REV.	FIGURE
19131361			9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0 25mm



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

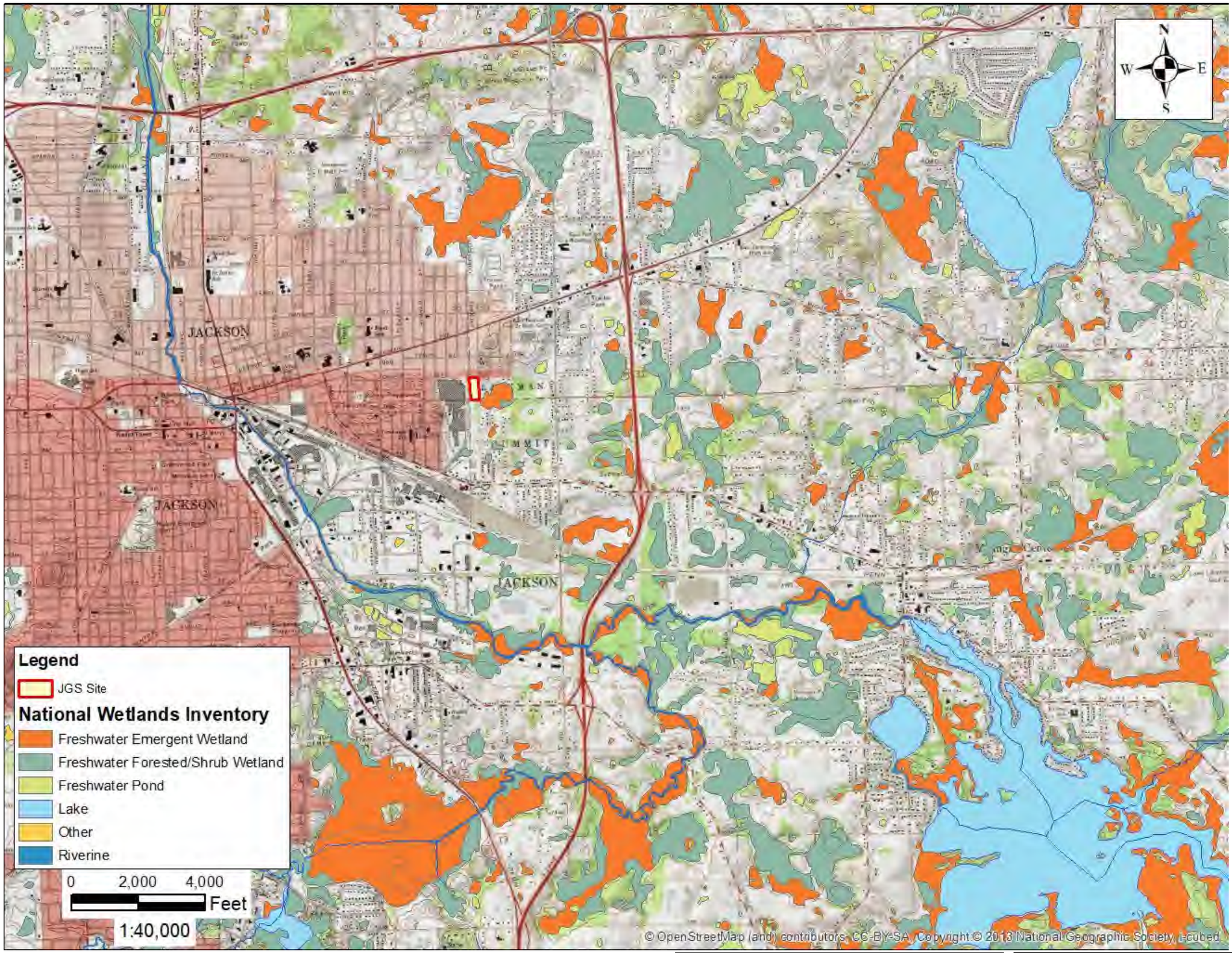
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
LOCAL WETLANDS

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm
0

https://golderassociates.sharepoint.com/sites/20127g/Deliverables/Forms/AllItems.aspx?viewpath=%2Fsites%2F20127g%2FDeliverables%2FForms%2FAllItems%2Easpx



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

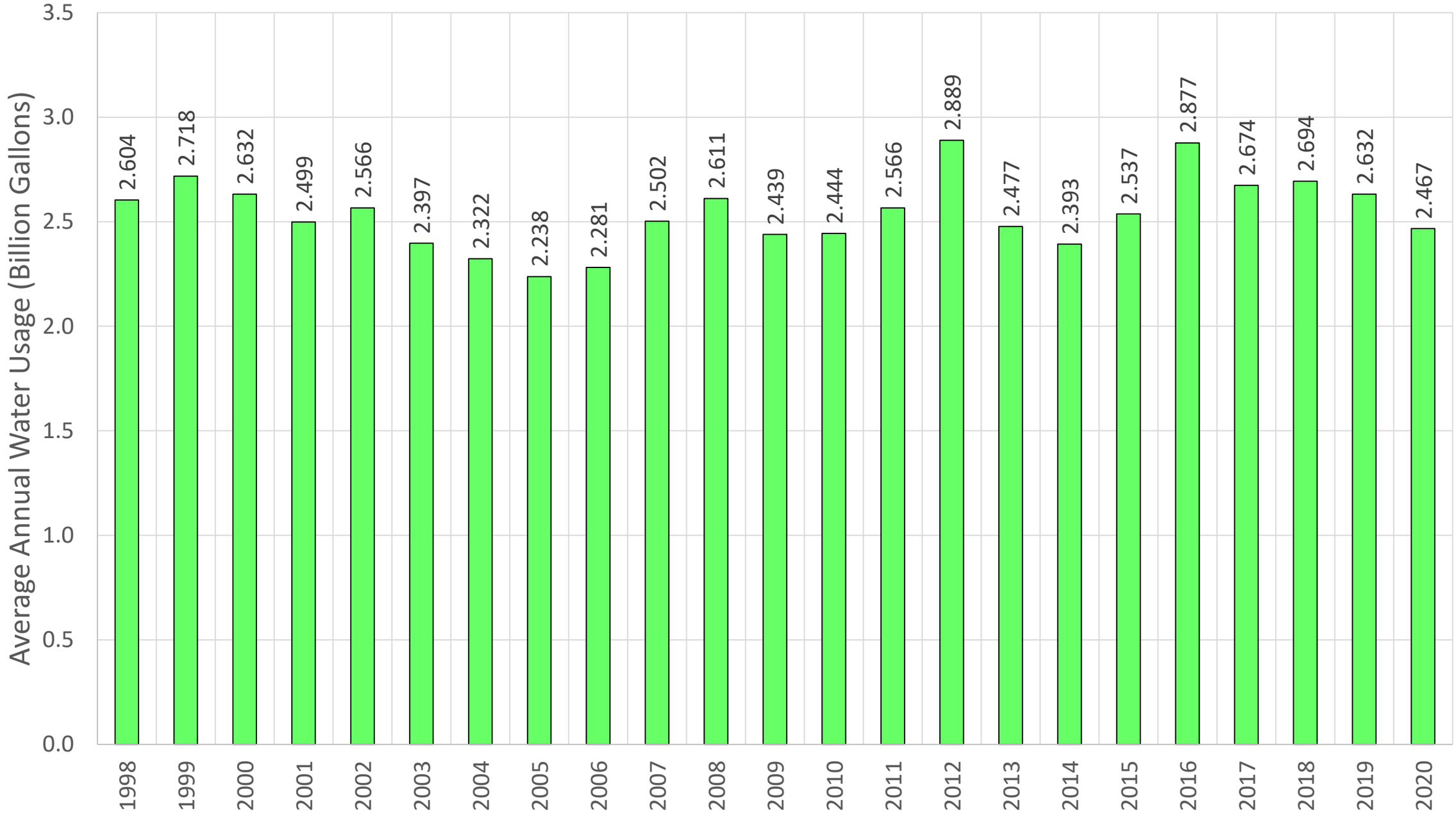
TITLE
REGIONAL WETLANDS

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

City Of Jackson
Municipal Water Usage 1998-2020



Source: Water Use Reporting, EGLE

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

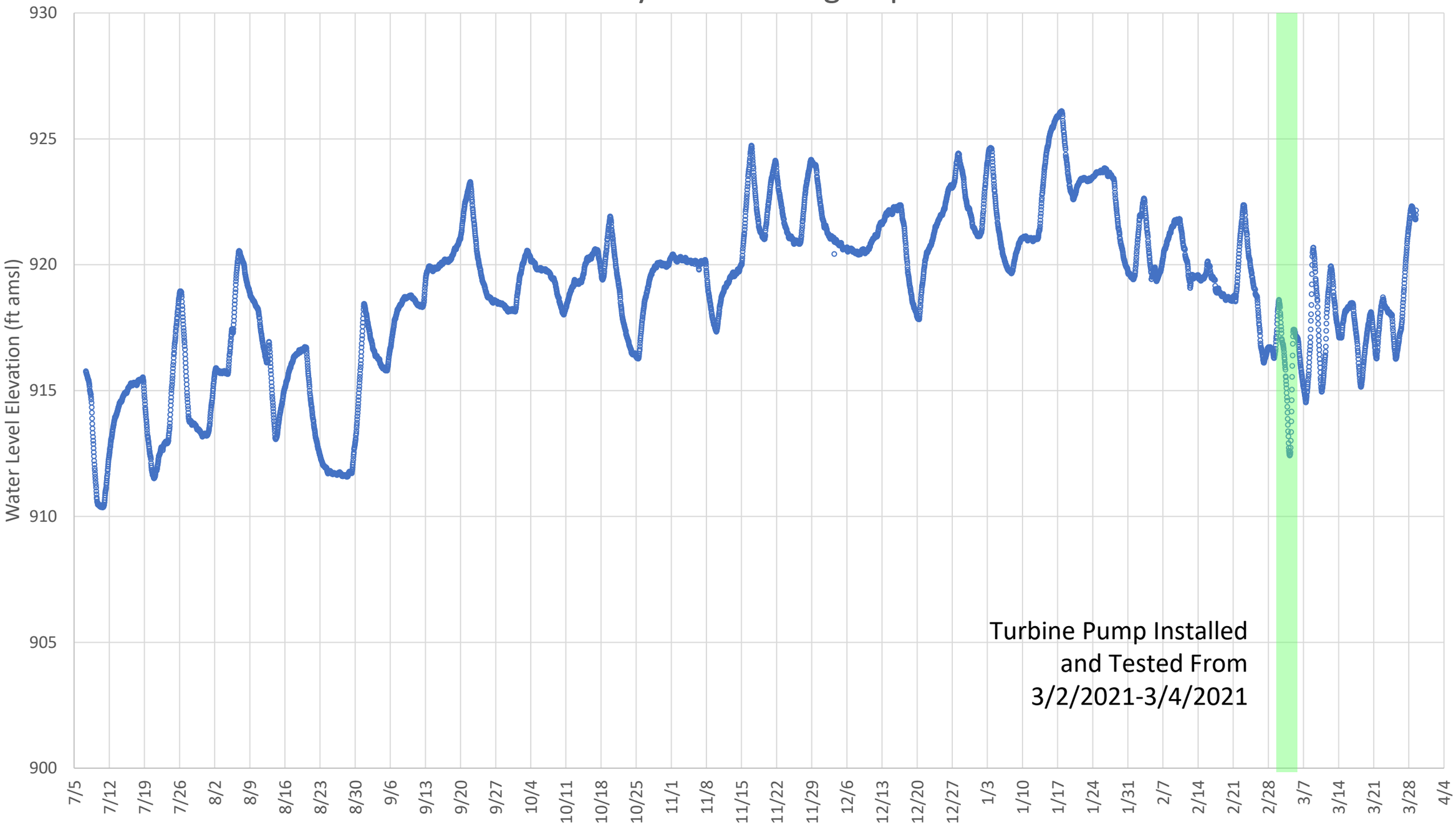
CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
CITY OF JACKSON MUNICIPAL WATER WITHDRAWALS, 1998-2020

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 12

Groundwater Levels at JGS Supply Well PW-1 – Prior to Use
July 2020 through April 2021



CLIENT
CONSUMERS ENERGY COMPANY

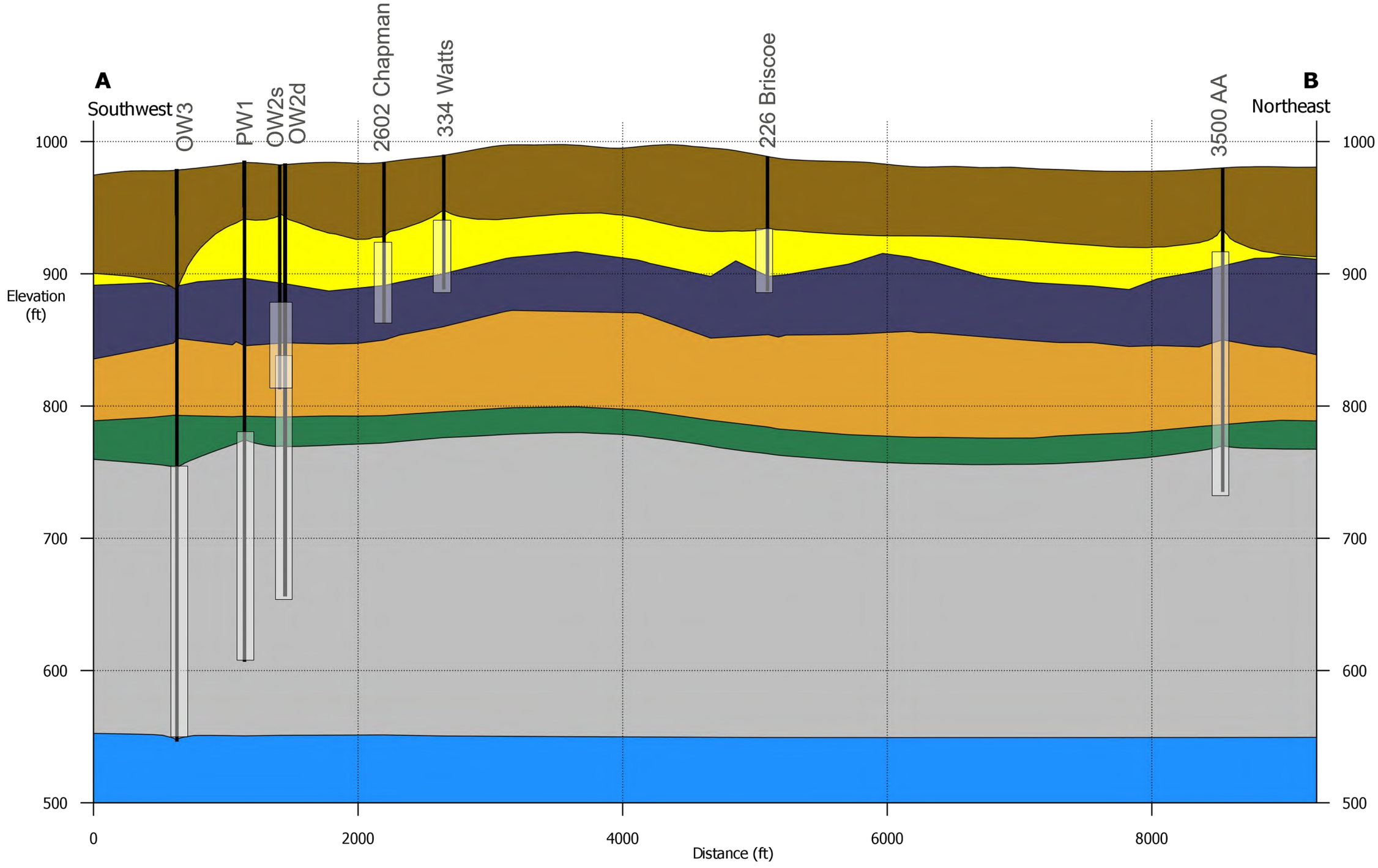
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
WATER LEVEL ELEVATIONS
SUPPLY WELL PW-1
JULY 2020 – APRIL 2021

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 13



Hydrostratigraphy

- Overburden
- Saginaw_Sandstone
- Saginaw_Confining
- Parma_Sandstone
- Bayport/Michigan
- Marshall_Sandstone
- Coldwater Shale

Scale: 1:10,000

Vertical exaggeration: 10x

0ft — 2000ft

CLIENT
CONSUMERS ENERGY COMPANY

CONSULTANT
GOLDER

YYYY-MM-DD	12-11-2021
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

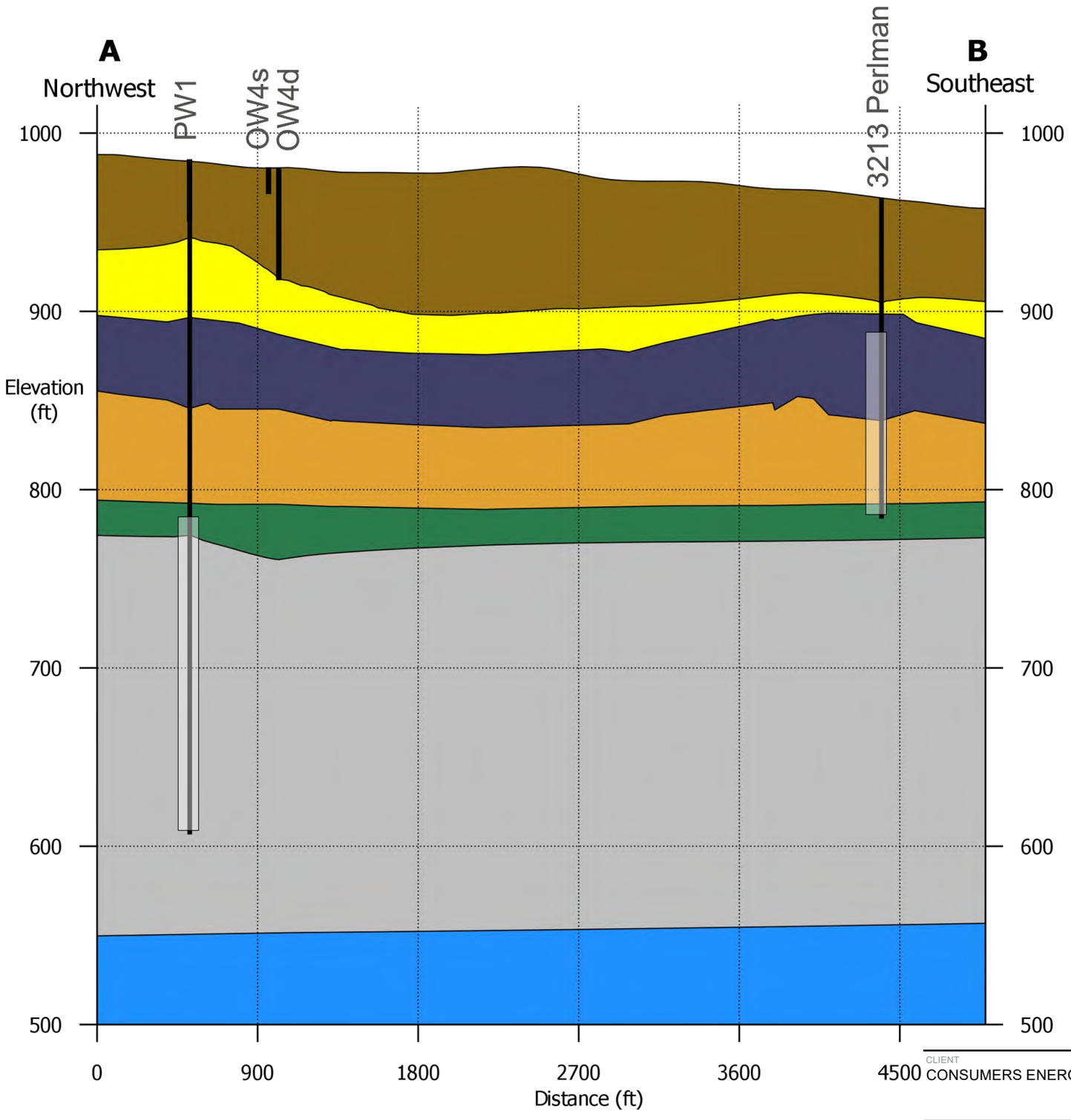
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
STRATIGRAPHIC CROSS SECTION
SOUTHWEST TO NORTHEAST

PROJECT NO. 19131361

REV.

14A



Hydrostratigraphy

- Overburden
- Saginaw_Sandstone
- Saginaw_Confining
- Parma_Sandstone
- Bayport/Michigan
- Marshall_Sandstone
- Coldwater Shale

Scale: 1:10,000

Vertical exaggeration: 10x

0ft — 2000ft

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

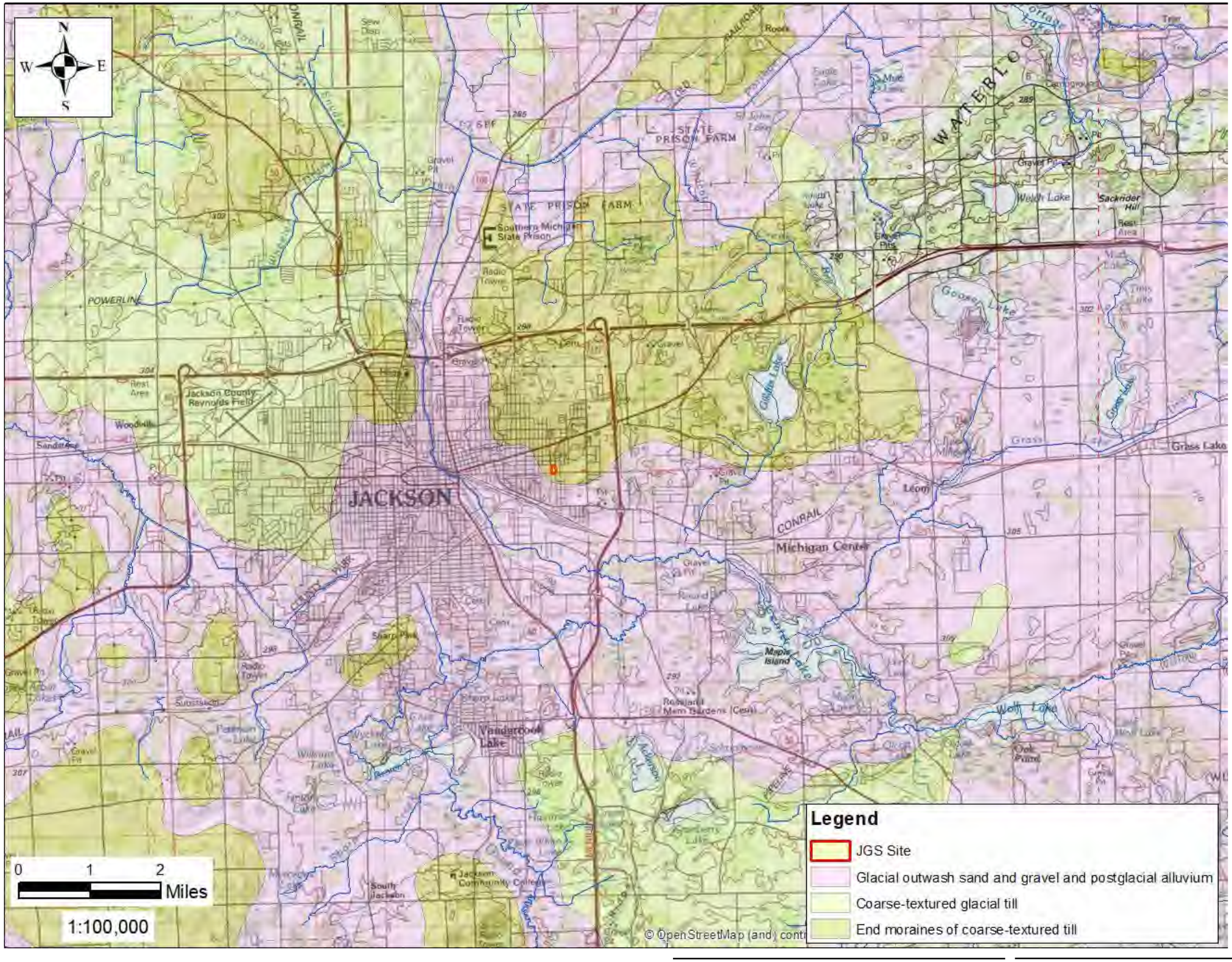
CONSULTANT
GOLDER

YYYY-MM-DD	12-11-2021
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
STRATIGRAPHIC CROSS SECTION
NORTHWEST TO SOUTHEAST

PROJECT NO.
19131361

REV.
14B



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

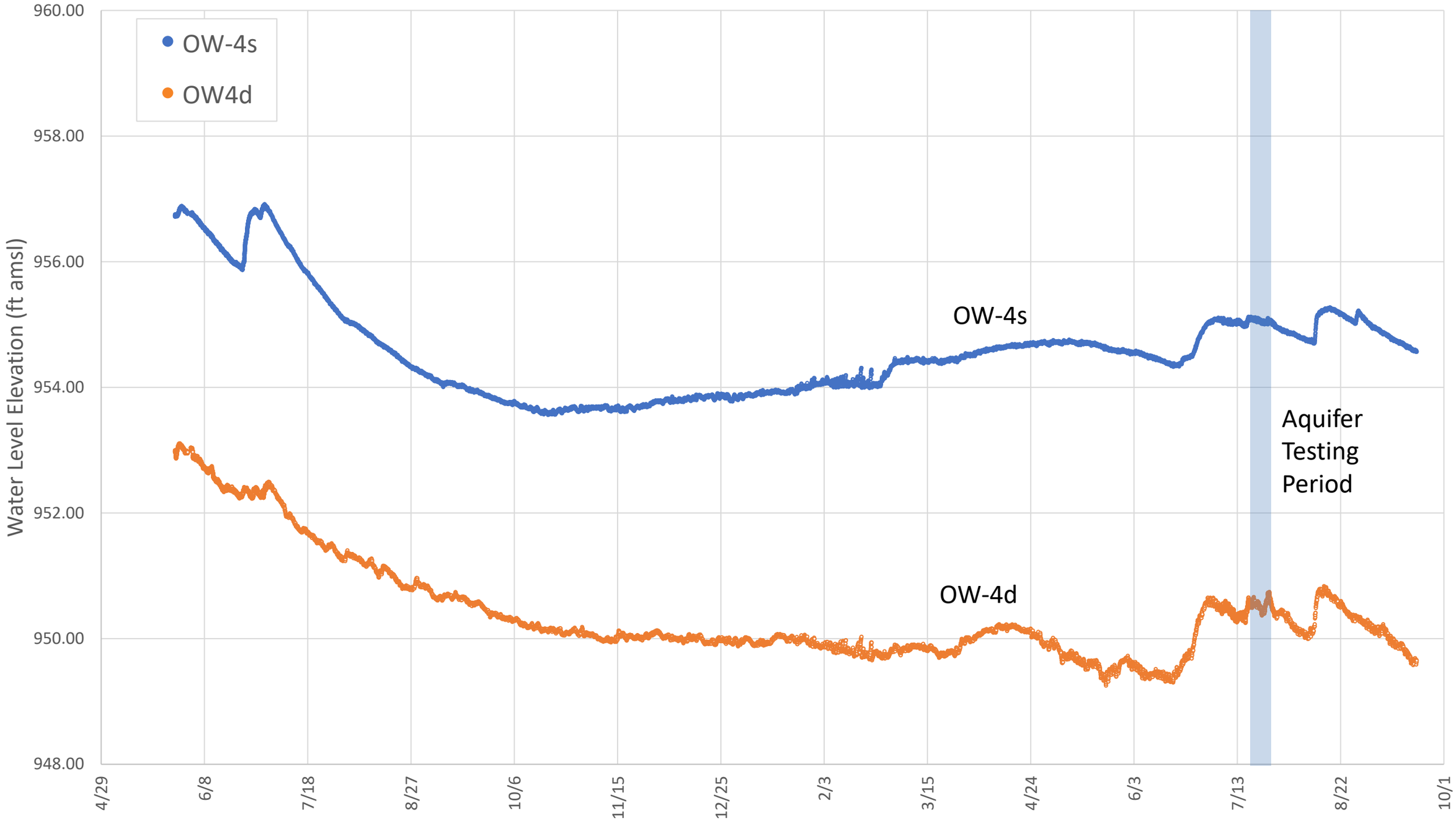
CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
QUATERNARY GEOLOGY

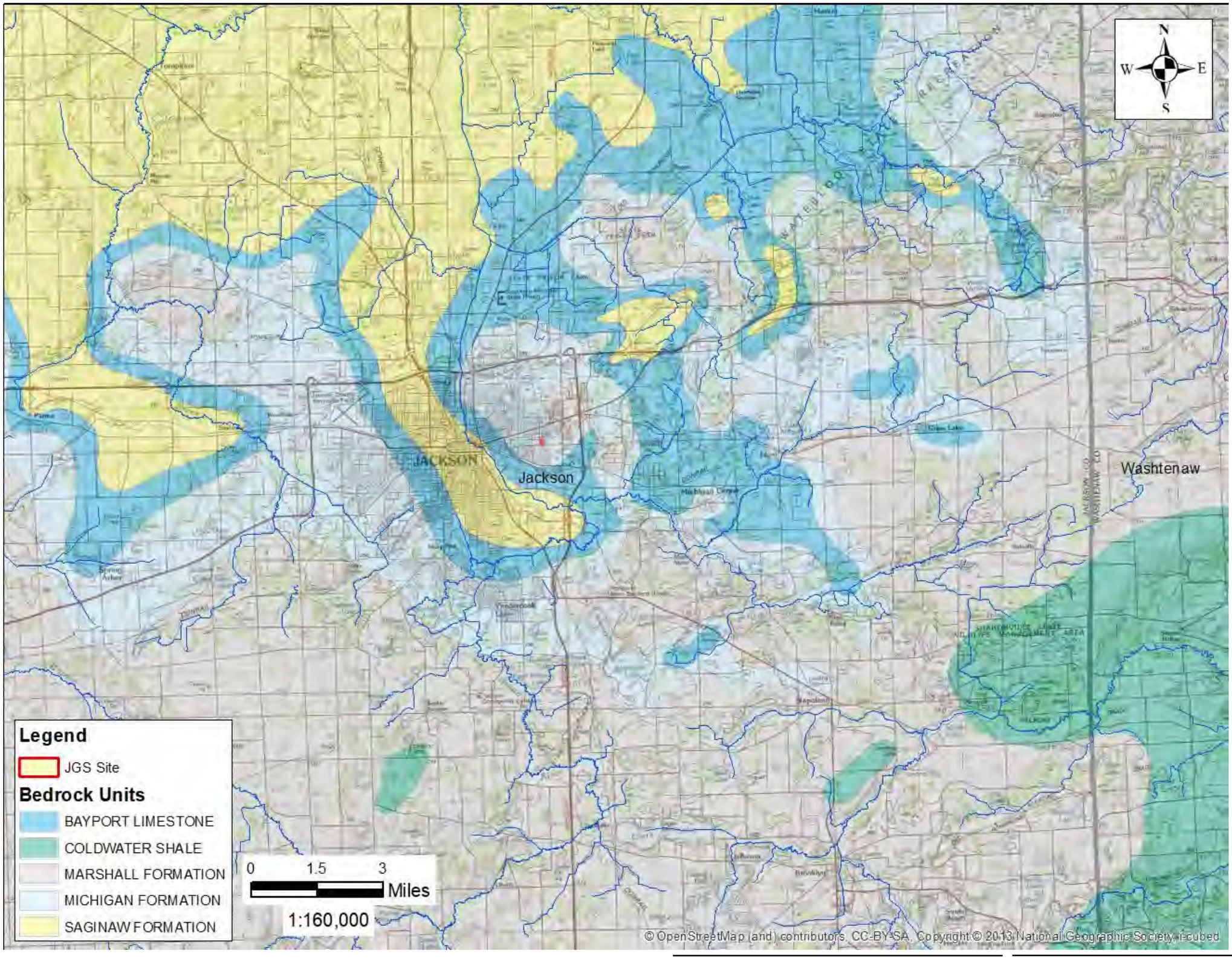
PROJECT NO. 19131361 CONTROL REV. FIGURE 15

Hydraulic Separation between Upper and Lower Overburden
Observation Wells OW-4S and OW-4D
May 2020 – September 2021



Notes:
OW-4s screened 9 to 14 ft bgs (954.06 – 949.06 ft amsl)
OW-4d screened 41 to 46 ft bgs (921.85 – 916.85 ft amsl)

CLIENT	CONSUMERS ENERGY COMPANY
CONSULTANT	GOLDER
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW
PROJECT	JACKSON GENERATING STATION WATER WITHDRAWAL PERMIT APPLICATION
TITLE	WATER LEVEL ELEVATIONS OBSERVATION WELLS OW-4S AND OW-4D MAY 2020 – SEPTEMBER 2021
PROJECT NO.	19131361
CONTROL	
REV.	
FIGURE	16



CLIENT
CONSUMERS ENERGY COMPANY

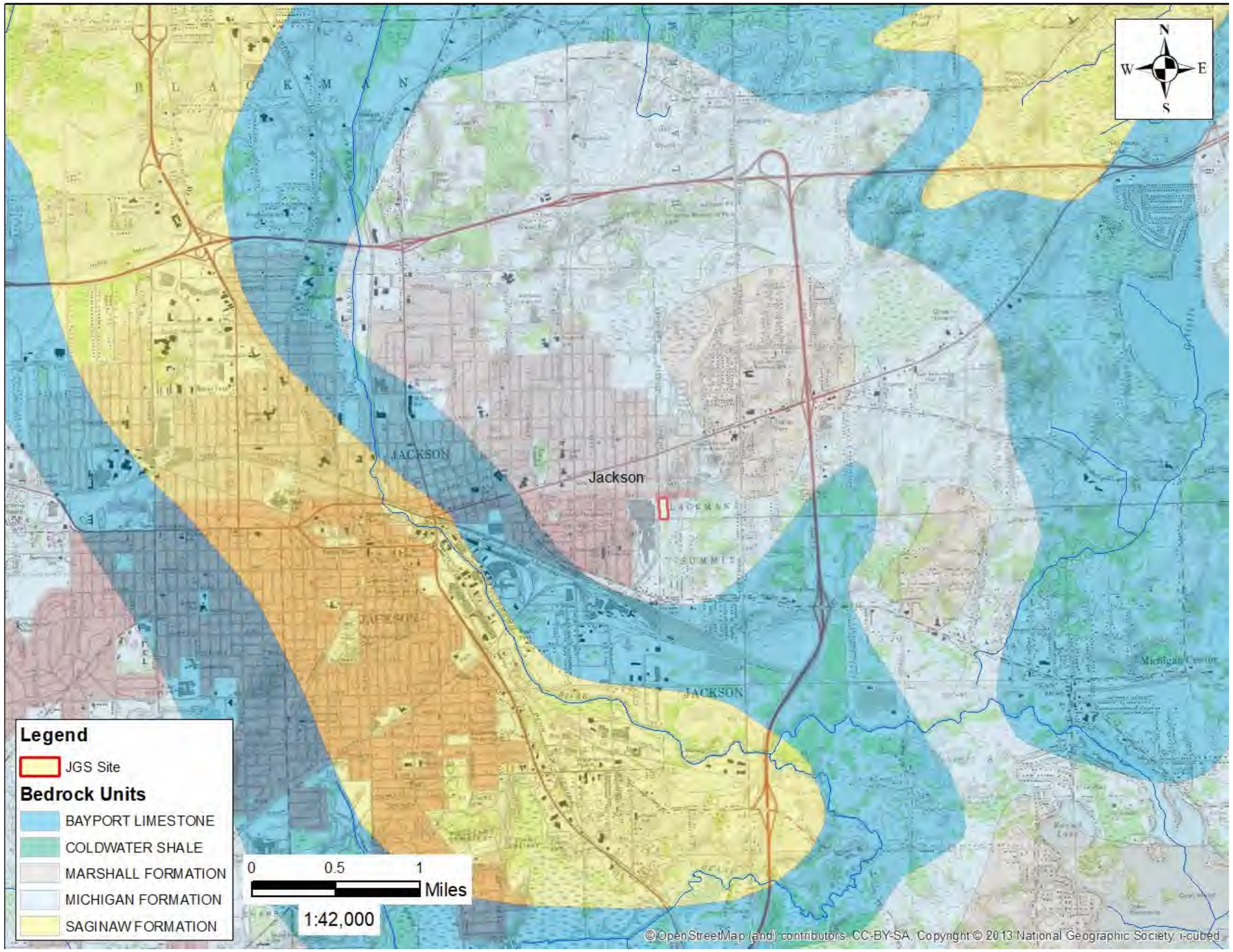
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
REGIONAL BEDROCK GEOLOGY

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 17A



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

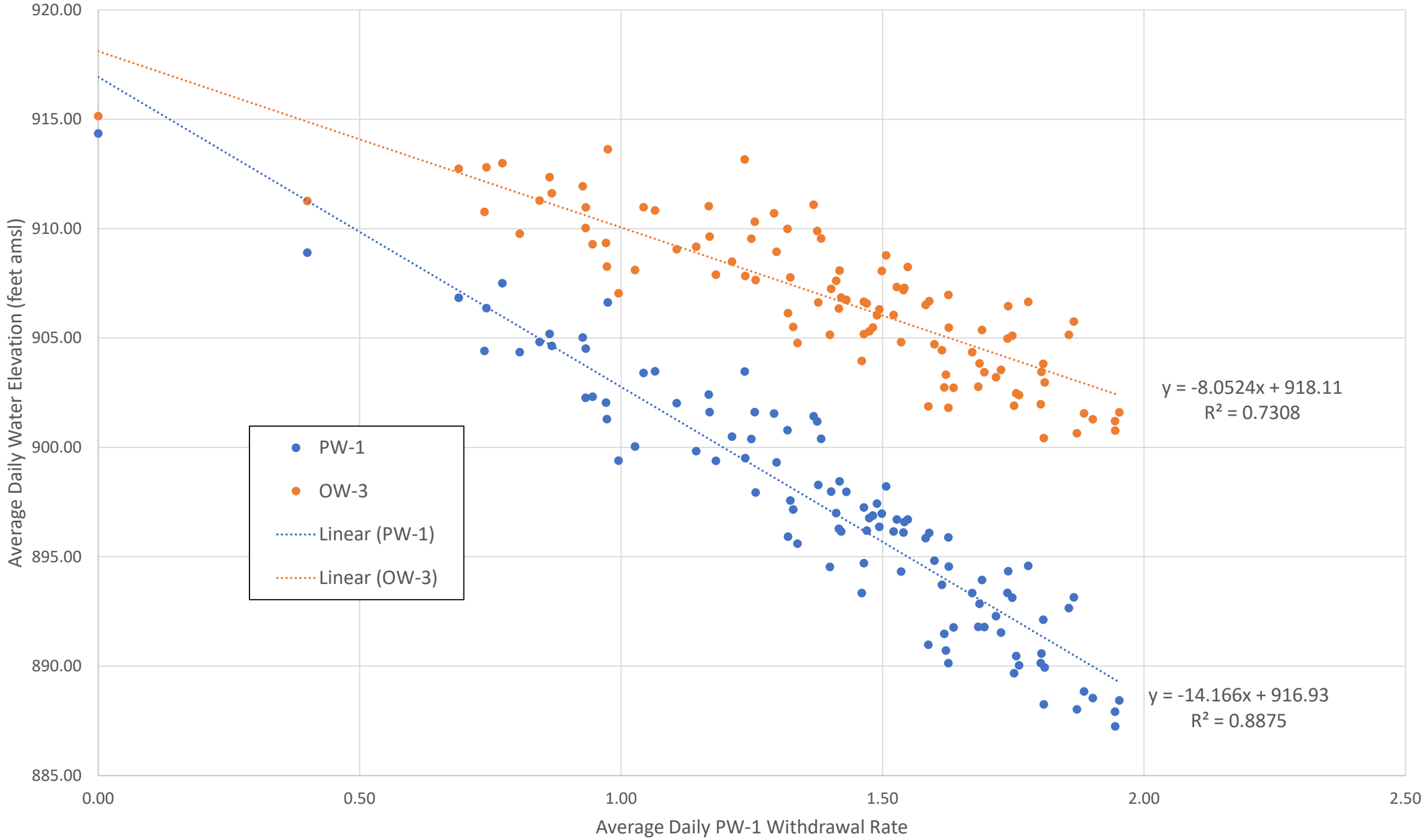
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
LOCAL BEDROCK GEOLOGY

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 17B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm
0

Regressions of JGS well PW-1 Pumping Rate against Water Levels at PW-1 and OW-3
June – September 2021



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
REGRESSIONS OF JGS-PW1 PUMPING RATE AGAINST WATER LEVELS AT PW-1 AND OW-3

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 18

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

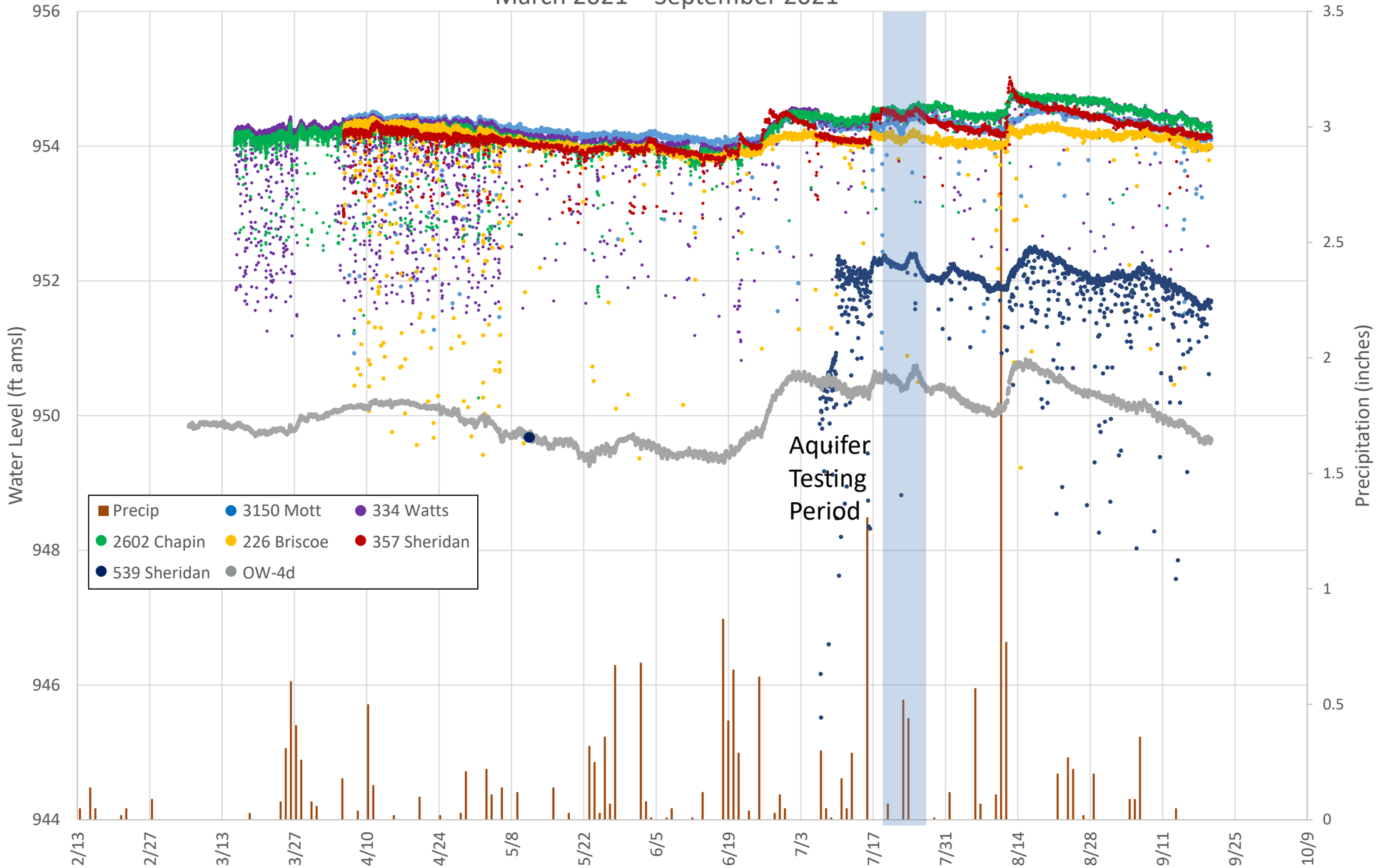
CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
PRIVATE WELL LOCATIONS

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 19

Saginaw and Overburden Aquifer Wells
March 2021 – September 2021



CLIENT
CONSUMERS ENERGY COMPANY

CONSULTANT
GOLDER

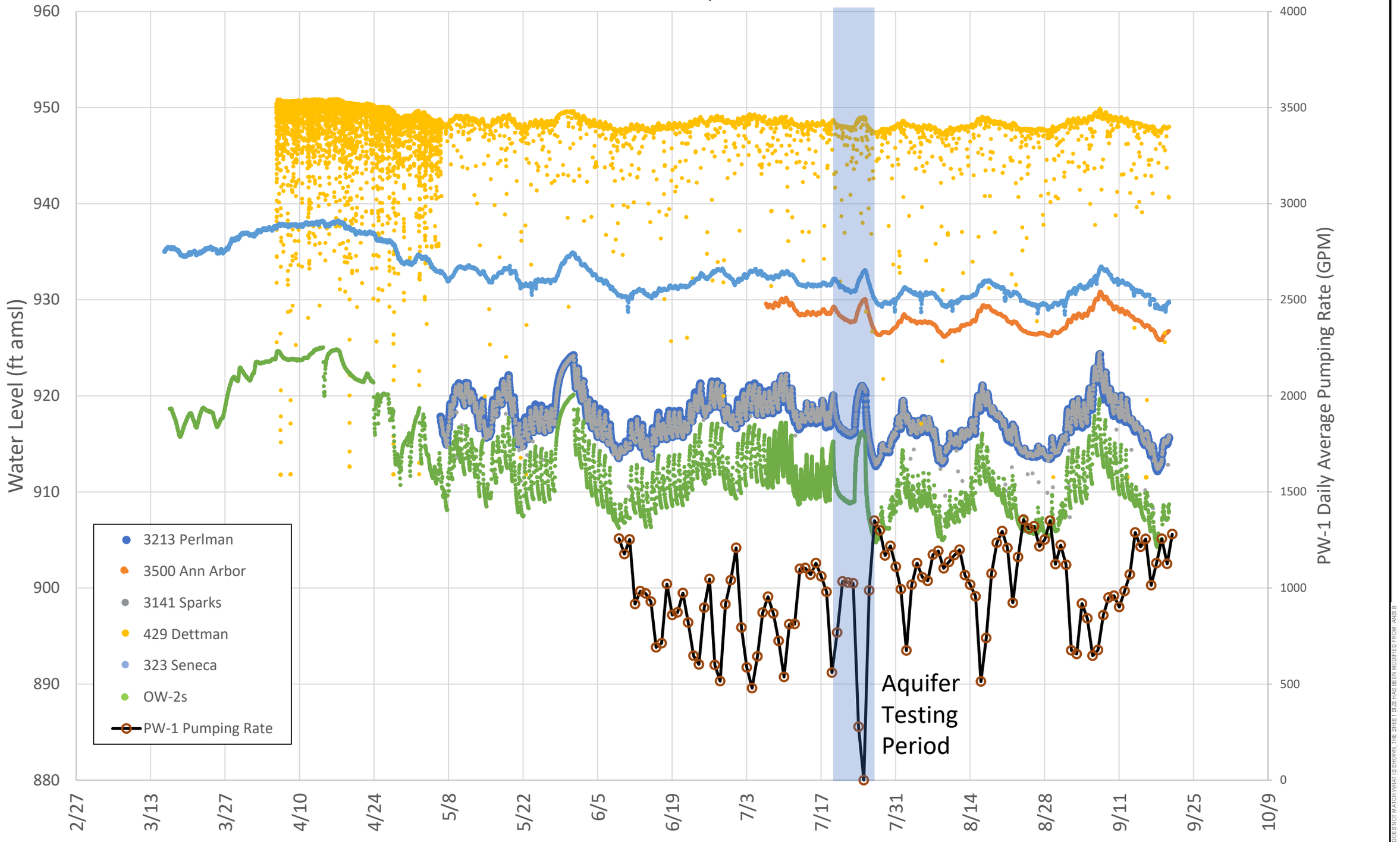
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
WATER LEVELS
SAGINAW AQUIFER AND OVERBURDEN WELLS
MARCH - SEPTEMBER 2021

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 20

Parma-Bayport Aquifer Wells
March 2021 – September 2021



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

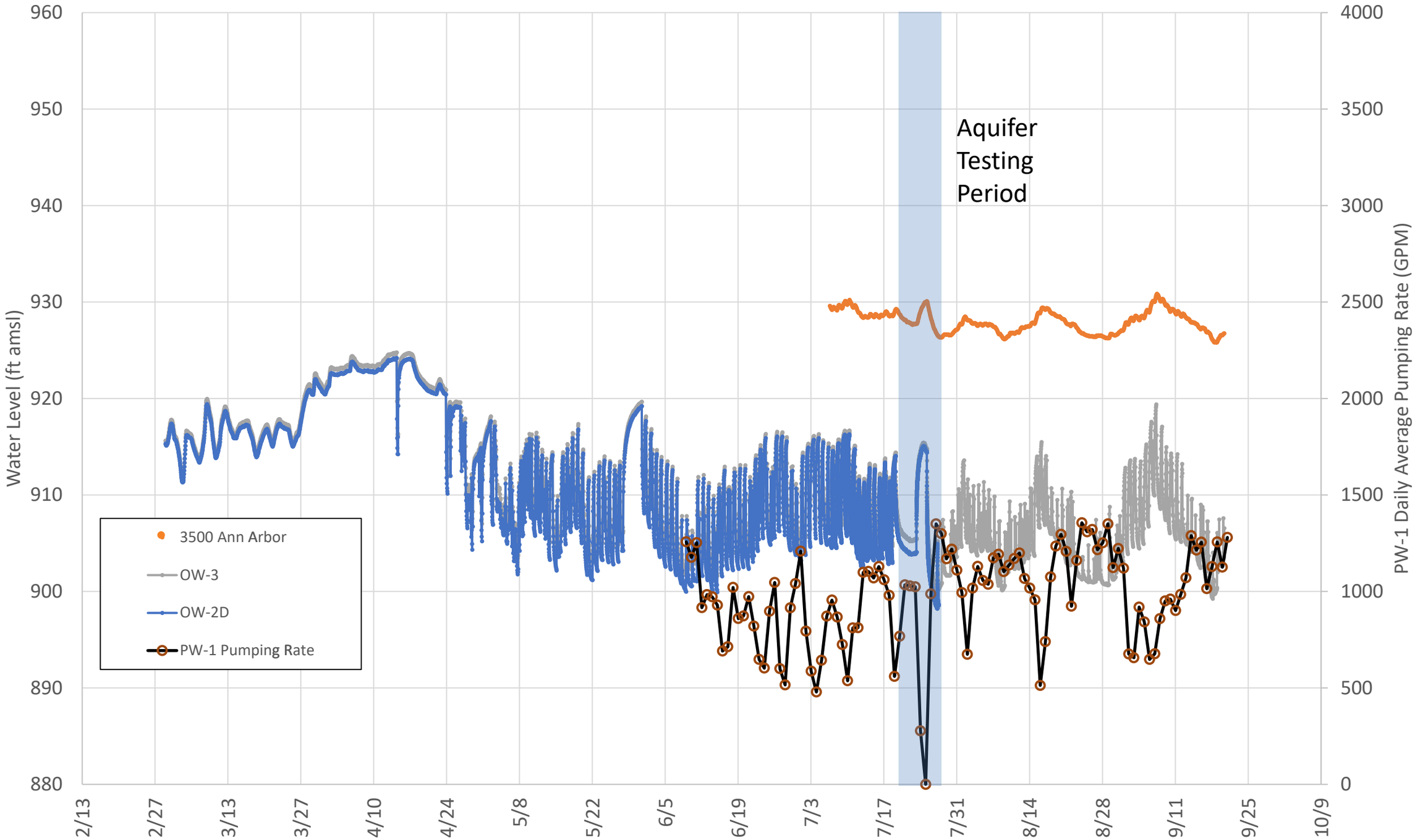
CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
WATER LEVELS
PARMA-BAYPORT AQUIFER WELLS
MARCH - SEPTEMBER 2021

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 21

Marshall Aquifer Wells
March 2021 – September 2021



CLIENT
CONSUMERS ENERGY COMPANY

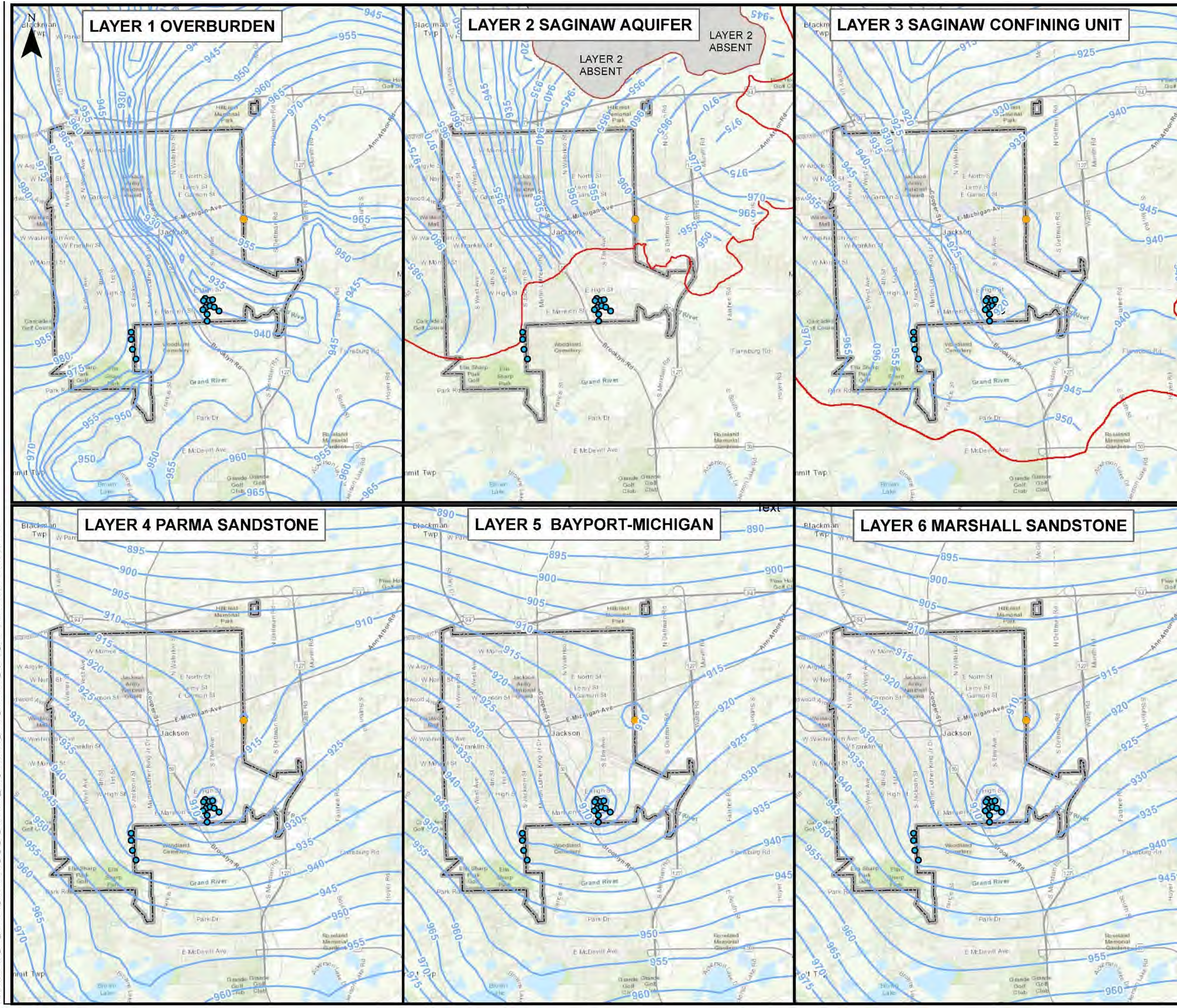
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
WATER LEVELS
MARSHALL AQUIFER WELLS
MARCH - SEPTEMBER 2021

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 22

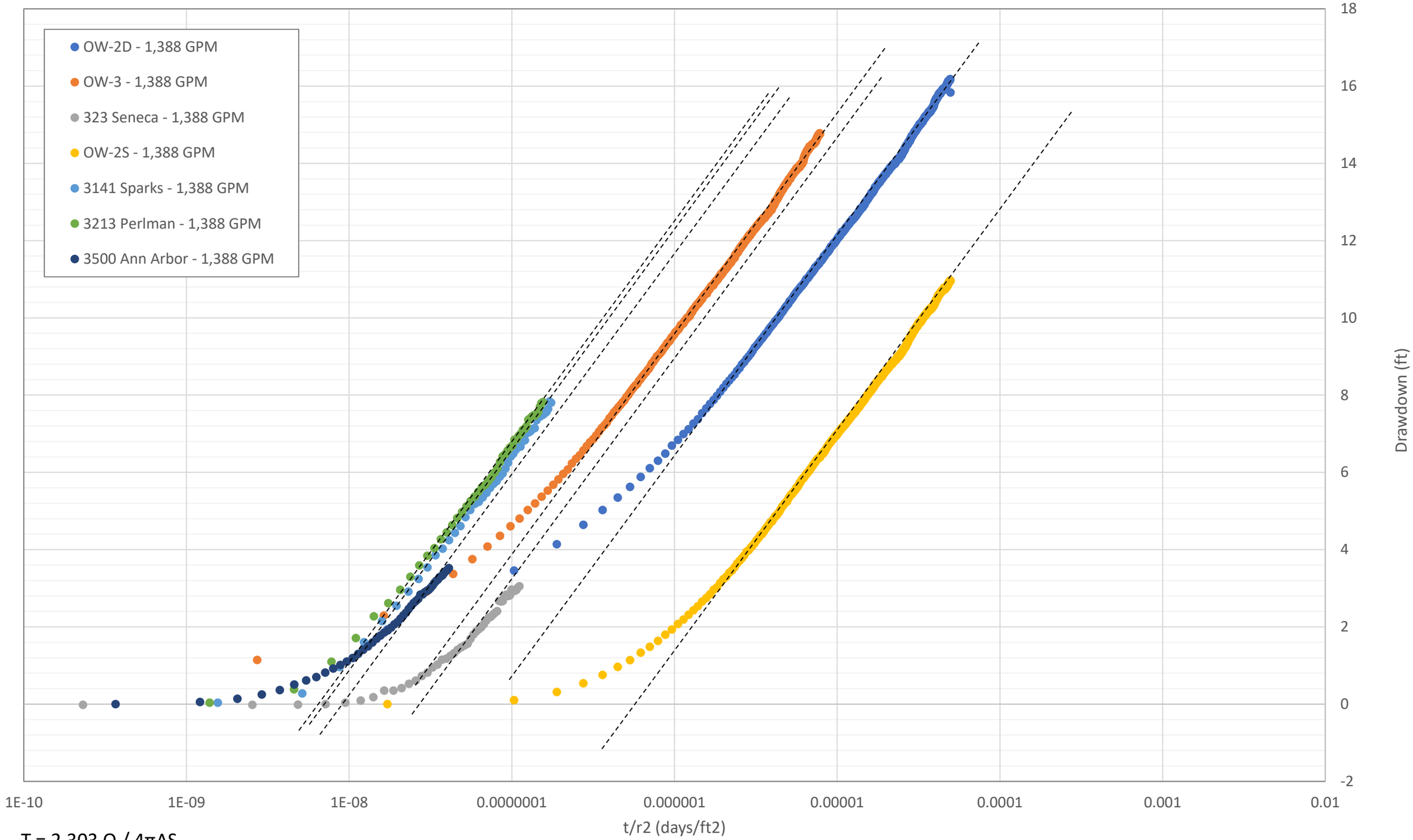


CLIENT	CONSUMERS ENERGY COMPANY
PROJECT	JACKSON GENERATING STATION WATER WITHDRAWAL PERMIT APPLICATION
CONSULTANT	GOLDER
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW
TITLE	MODELLED GROUNDWATER FLOW DIRECTIONS
PROJECT NO.	19131361
CONTROL	
REV.	
FIGURE	23

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

Distance-Normalized Drawdown
Jackson Generating Station PW-1, 1388 GPM for 48 hours



$T = 2.303\ Q / 4\pi\Delta S$

$T = 2.303\ (1388\ GPM) / 4\pi\ (5.75\ ft)$

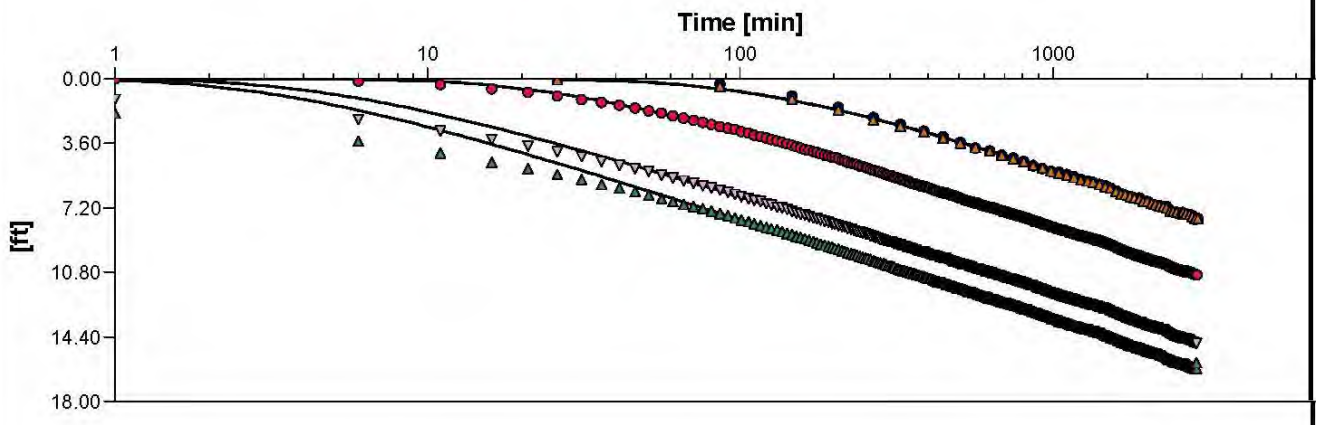
$T = 8{,}500\ ft^2/day$

$S = 2.25\ (T)(t_0)$

CLIENT	CONSUMERS ENERGY COMPANY
CONSULTANT	GOLDER
YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW
PROJECT	JACKSON GENERATING STATION WATER WITHDRAWAL PERMIT APPLICATION
TITLE	DISTANCE-NORMALIZED DRAWDOWN JULY 19-27, 2021 AQUIFER TEST
PROJECT NO.	19131361
CONTROL	
REV.	
FIGURE	24

	Pumping Test Analysis Report
	Project: Jackson Pump Tests
	Number: 19131361
	Client: CEC

Location: Jackson, MI	Pumping Test: Pumping Test 2 Saturday	Pumping Well: Well 1
Test Conducted by:		Test Date: 7/31/2021
Analysis Performed by:	New analysis 1	Analysis Date: 7/31/2021
Aquifer Thickness: 200.00 ft	Discharge Rate: 1388 [U.S. gal/min]	



Calculation using Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
OW-2S	8.50×10^{3}	4.25×10^{1}	1.19×10^{-2}	200.11	
OW-2D	8.60×10^{3}	4.30×10^{1}	1.40×10^{-3}	201.42	
OW-3	9.00×10^{3}	4.50×10^{1}	3.50×10^{-4}	505.15	
3141 Sparks	8.00×10^{3}	4.00×10^{1}	1.70×10^{-4}	3405.33	
3213 Perlman	8.00×10^{3}	4.00×10^{1}	1.50×10^{-4}	3608.93	
Average	8.42×10^{3}	4.21×10^{1}	2.79×10^{-3}		

LEGEND

NOTE(S)
1.
2.

REFERENCE

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
PART 327 PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGN	JCH
REVIEW	AO
APPROVED	MW

TITLE
AQUIFER TESTING RESULTS
NEARBY PARMA AND MARSHALL AQUIFER WELLS

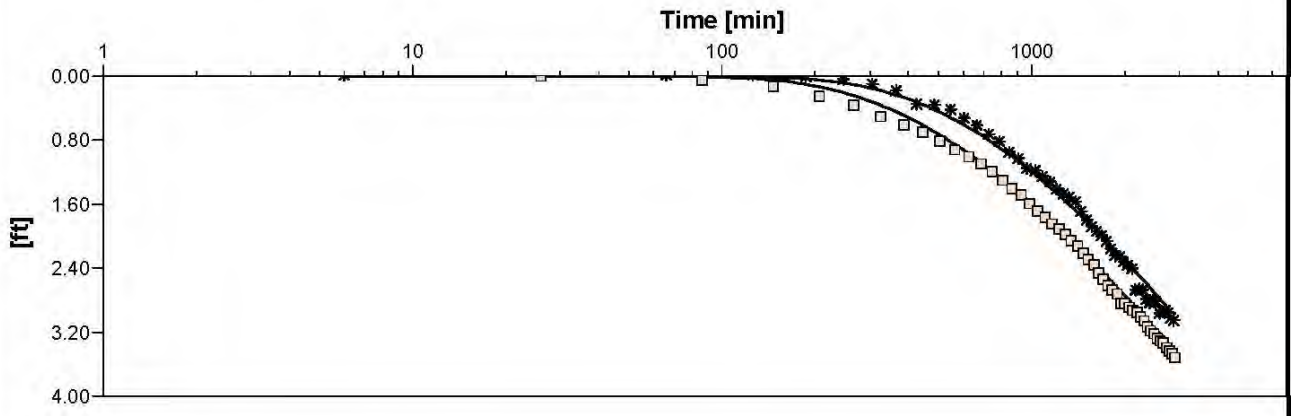
PROJECT No.	PHASE	Rev.	FIGURE
19131361	**----**	**----**	**25A**

FILE PATH: XXX

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A

	Pumping Test Analysis Report
	Project: Jackson Pump Tests
	Number: 19131361
	Client: CEC

Location: Jackson, MI	Pumping Test: Pumping Test 2 Saturday	Pumping Well: Well 1
Test Conducted by:		Test Date: 7/31/2021
Analysis Performed by:	New analysis 1	Analysis Date: 7/31/2021
Aquifer Thickness: 200.00 ft	Discharge Rate: 1388 [U.S. gal/min]	



Calculation using Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
323 Seneca	9.00×10^{3}	4.50×10^{1}	7.60×10^{-4}	4247.33	
3500 Ann Arbor	9.80×10^{3}	4.90×10^{1}	2.10×10^{-4}	7020.73	
Average	9.40×10^{3}	4.70×10^{1}	4.85×10^{-4}		

LEGEND

NOTE(S)
1.
2.

REFERENCE

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
PART 327 PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGN	JCH
REVIEW	AO
APPROVED	MW

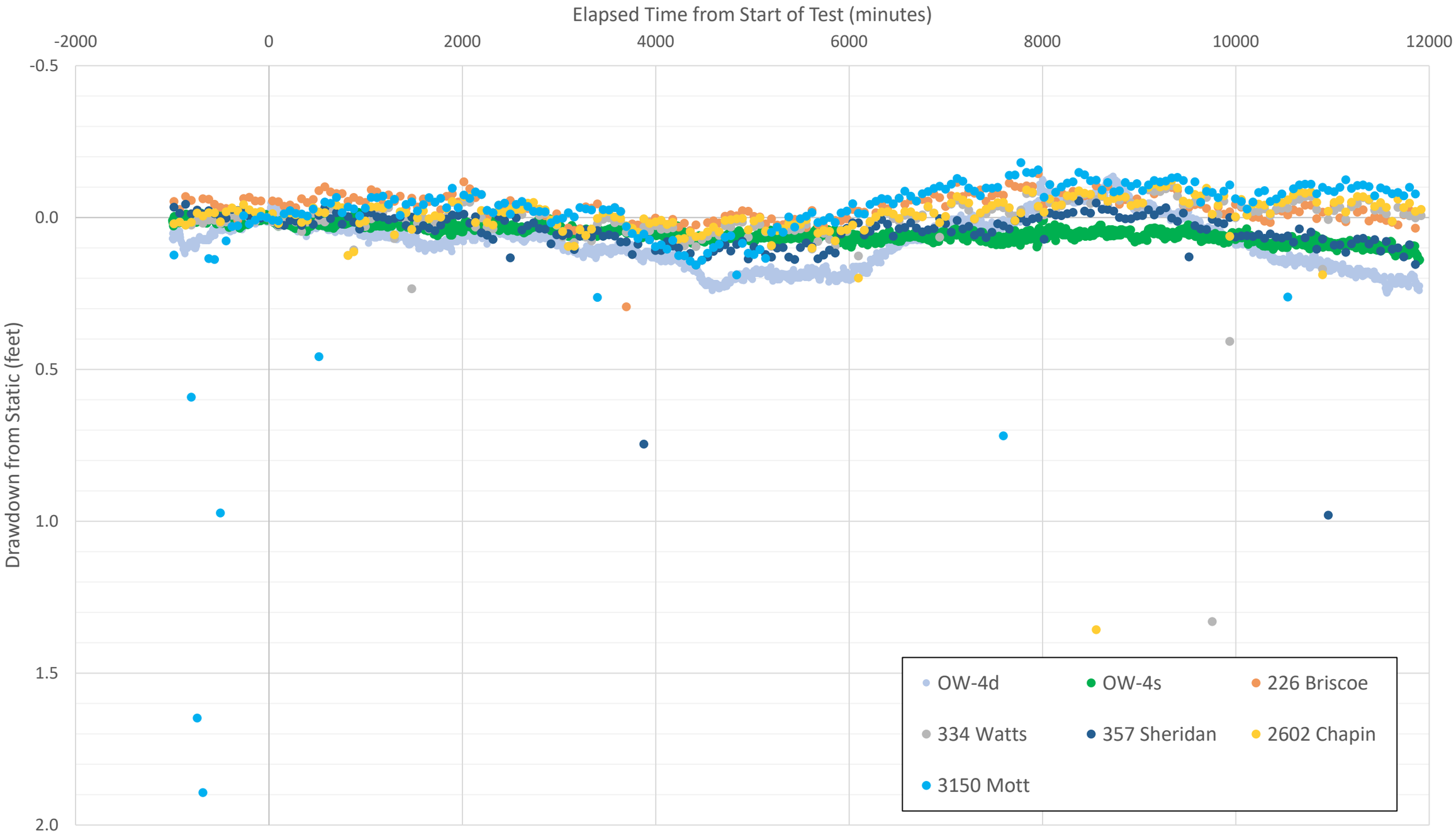
TITLE
AQUIFER TESTING RESULTS
DISTANT PARMA AND MARSHALL AQUIFER WELLS

PROJECT No.	PHASE	Rev.	FIGURE
19131361	**----**	**A**	**25B**

FILE PATH: XXX

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A

Saginaw Aquifer and Overburden Wells
July 19-27 Aquifer Pumping Test



Testing Schedule: Pumping JGS-PW-1 for

- 1050 GPM for 96 hours (5,760 min) beginning 7:30 AM, 7/19/21
- 0 GPM for 48 hours (2,880 min) beginning 7:30 AM, 7/23/21
- 1388 GPM for 48 hours (2,880 min) beginning 7:30 AM, 7/25/21

CLIENT: CONSUMERS ENERGY COMPANY

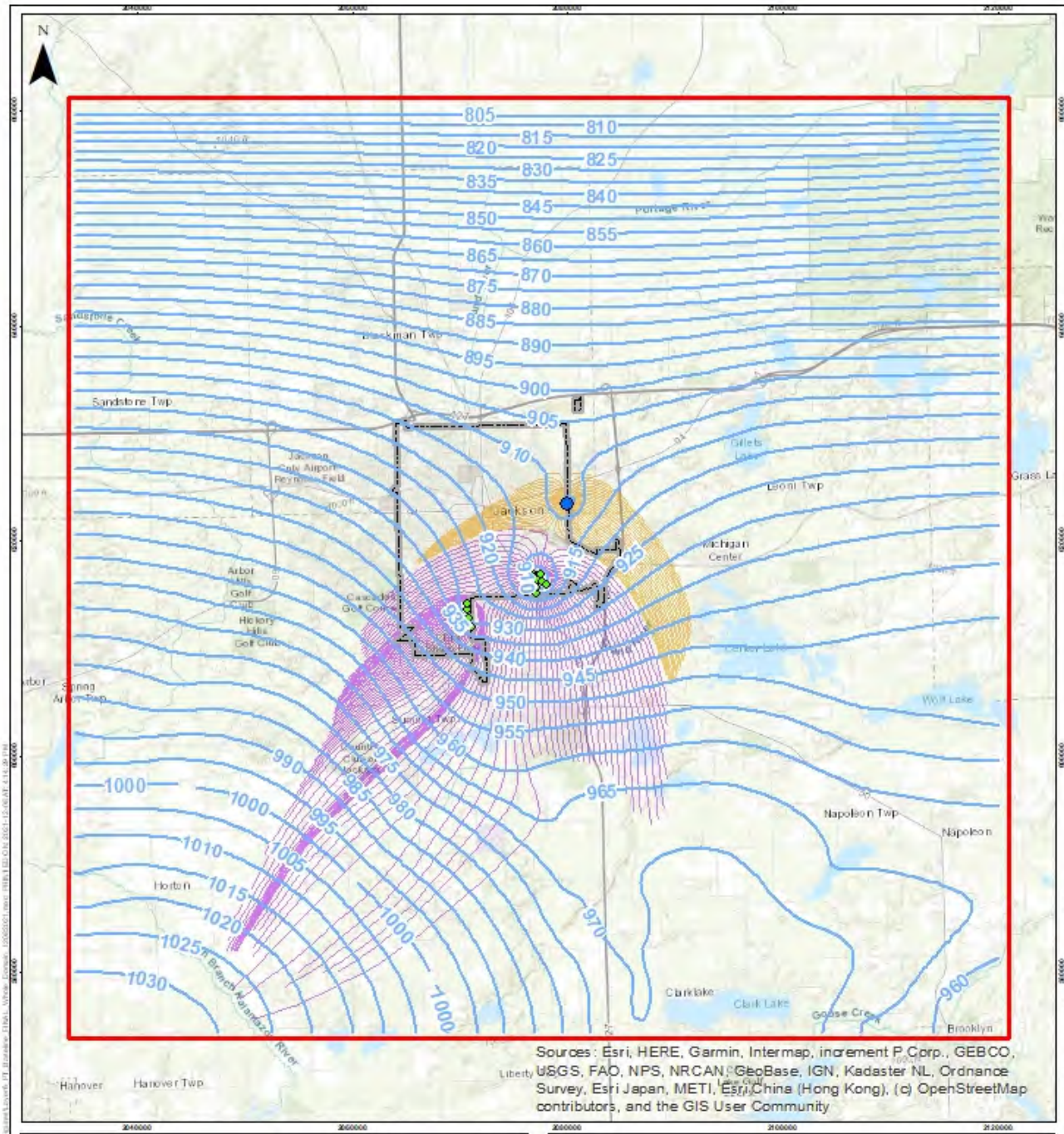
CONSULTANT: GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

PROJECT: JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE: SAGINAW AQUIFER AND OVERBURDEN WATER LEVELS, AQUIFER PUMPING TEST JULY 19-27, 2921

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE 26



Contour Interval = 5 ft

0 10,000 20,000

Feet

- JGS Supply Well
- City of Jackson Wells
- Groundwater Elevation (ft NAVD88)
- City of Jackson
- Model Domain

Flowpaths

- JGS Supply Well
- City of Jackson Wells

NOTE(S)

1. JGS PUMPING RATE = 1.4 MGD; CITY OF JACKSON PUMPING RATE = 5.8 MGD
1. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
2. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT

CONSUMERS ENERGY COMPANY

PROJECT

JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE

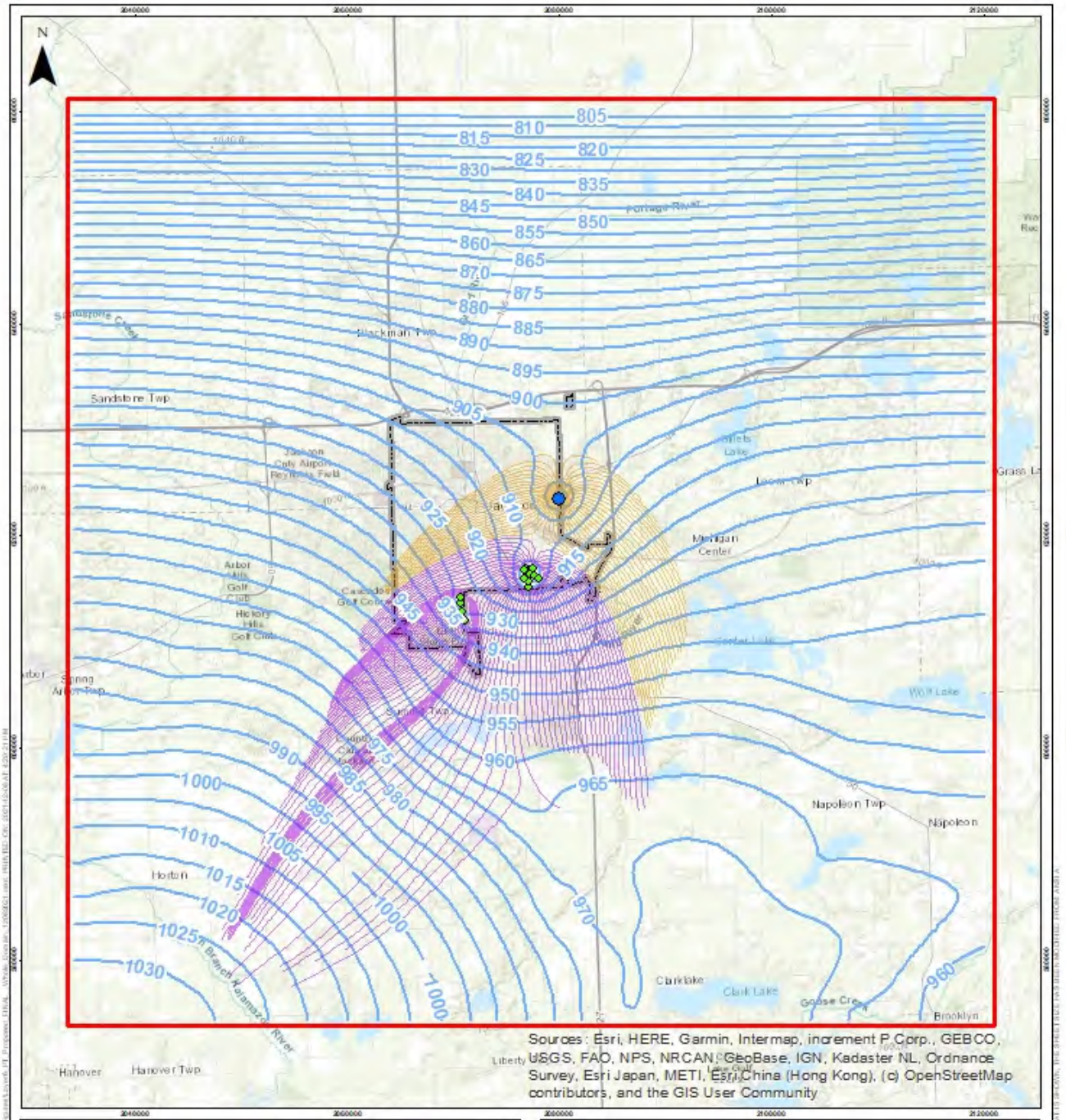
SIMULATED CAPTURE ZONES FOR BASELINE CONDITIONS IN THE MARSHALL SANDSTONE

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	11-16-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO.	REV.	FIGURE
19131361	0	27-A



0 10,000 20,000

Feet

Contour Interval = 5 ft

- JGS Supply Well
- City of Jackson Wells
- Groundwater Elevation (ft NAVD88)
- City of Jackson
- Model Domain

Flowpaths

- JGS Supply Well
- City of Jackson Wells

NOTE(S)

1. JGS PUMPING RATE = 2.76 MGD, CITY OF JACKSON PUMPING RATE = 5.12 MGD
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN VERTICAL DATUM OF 1983 MICHIGAN GEOREF (US FEET)
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD1988)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT

CONSUMERS ENERGY COMPANY

PROJECT

JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE

SIMULATED CAPTURE ZONES FOR PROPOSED PUMPING CONDITIONS IN THE MARSHALL SANDSTONE

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	11-23-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO.	REV.	FIGURE
19131361	0	27-B

ATTACHMENT A

Site Documentation

A-1

EGLE Water Well Record, PW-1

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Import ID:

Tax No:	**Permit No:** 19929	**County:** Jackson		**Township:** Blackman
		Town/Range: 02S 01W	**Section:** 36	**Well Status:** Active	**WSSN:**	**Source ID/Well No:** PW1

Well ID: 38000014769

Elevation:

Latitude: 42.2489827

Longitude: -84.3745715

Method of Collection: GPS Std Positioning Svc SA On

Distance and Direction from Road Intersection:
270' W of Roberts Rd. & 790' S of Tyson St.

Well Owner: Consumers Energy

Well Address:	**Owner Address:**
2219 Chapin St. Jackson, MI 49203	2219 Chapin St. Jackson, MI 49203

Drilling Method: Rotary
Well Depth: 365.00 ft. **Well Use:** Test well
Well Type: New **Date Completed:** 6/24/2020

Casing Type: Steel - black **Height:** 1.58 ft. above grade
Casing Joint: Welded
Casing Fitting: None

Diameter: 16.00 in. to 191.00 ft. depth

Borehole: 20.00 in. to 191.00 ft. depth
15.80 in. to 365.00 ft. depth

Pump Installed: No
Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 54.71 ft. Below Grade
Well Yield Test: **Yield Test Method:** Test pump
Pumping level 76.08 ft. after 5.00 hrs. at 1356 GPM

Screen Installed: No **Intake:** Bedrock Well

Formation Description	Thickness	Depth to Bottom
Topsoil	8.00	8.00
Sand W/Clay W/Gravel	22.00	30.00
Sandstone W/Gravel	7.00	37.00
Sandstone W/Shale	21.00	58.00
Sandstone	17.00	75.00
Shale	6.00	81.00
Sandstone W/Limestone	19.00	100.00
Shale W/Sandstone	26.00	126.00
Sandstone	47.00	173.00
Shale	3.00	176.00
Sandstone	12.00	188.00
Limestone	9.00	197.00
Sandstone	168.00	365.00

Well Grouted: Yes **Grouting Method:** Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Neat cement	170.00	None	0.00 ft. to 191.00 ft.

Wellhead Completion: 12 inches above grade

Nearest Source of Possible Contamination:

Type	Distance	Direction
None		

Geology Remarks:

Drilling Machine Operator Name: Gregg Burks
Employment: Employee

Contractor Type: Water Well Drilling Contractor **Reg No:** 91-2615
Business Name: Peerless Midwest Inc
Business Address: 55860 Russell I.p., Mishawaka, IN, 46545

Water Well Contractor's Certification

This well and/or pump installation was performed under my registration.

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks:

A-2

PW-1 Water Withdrawal Registration, ID #7684-20213-10

Michigan's Water Withdrawal Assessment Tool
Department of Environmental Quality

Print

Registration Receipt

MICHIGAN.GOV Michigan's Official Web Site

Registration ID: 7684-20213-10

Date Passed: 3/15/2021

IMPORTANT - PLEASE READ

This registration is only valid for the withdrawal characteristics listed below. Any changes MUST be authorized by modifying the registration before making the withdrawal. To modify this registration, rerun the Water Withdrawal Assessment Tool with the new characteristics and proceed as directed. Registration expires after 18 months if the withdrawal is not constructed. Please contact the DEQ with any questions. Please print this page using the print button in the upper right hand corner of the page, and save with your records as a copy of your receipt.

Contact Information

Owner/Representive: Owner MDA Receiving Agency: No

Property Owner Contact Information

Name:	Rachel Proctor
Facility Name:	Consumers Energy - Jackson Generating Station
Address:	1945 W. Parnall Rd
City:	Jackson
State:	MI
Zip Code:	49201
Phone:	517-123-4567
e-mail:	rachel.proctor@cmsenergy.com

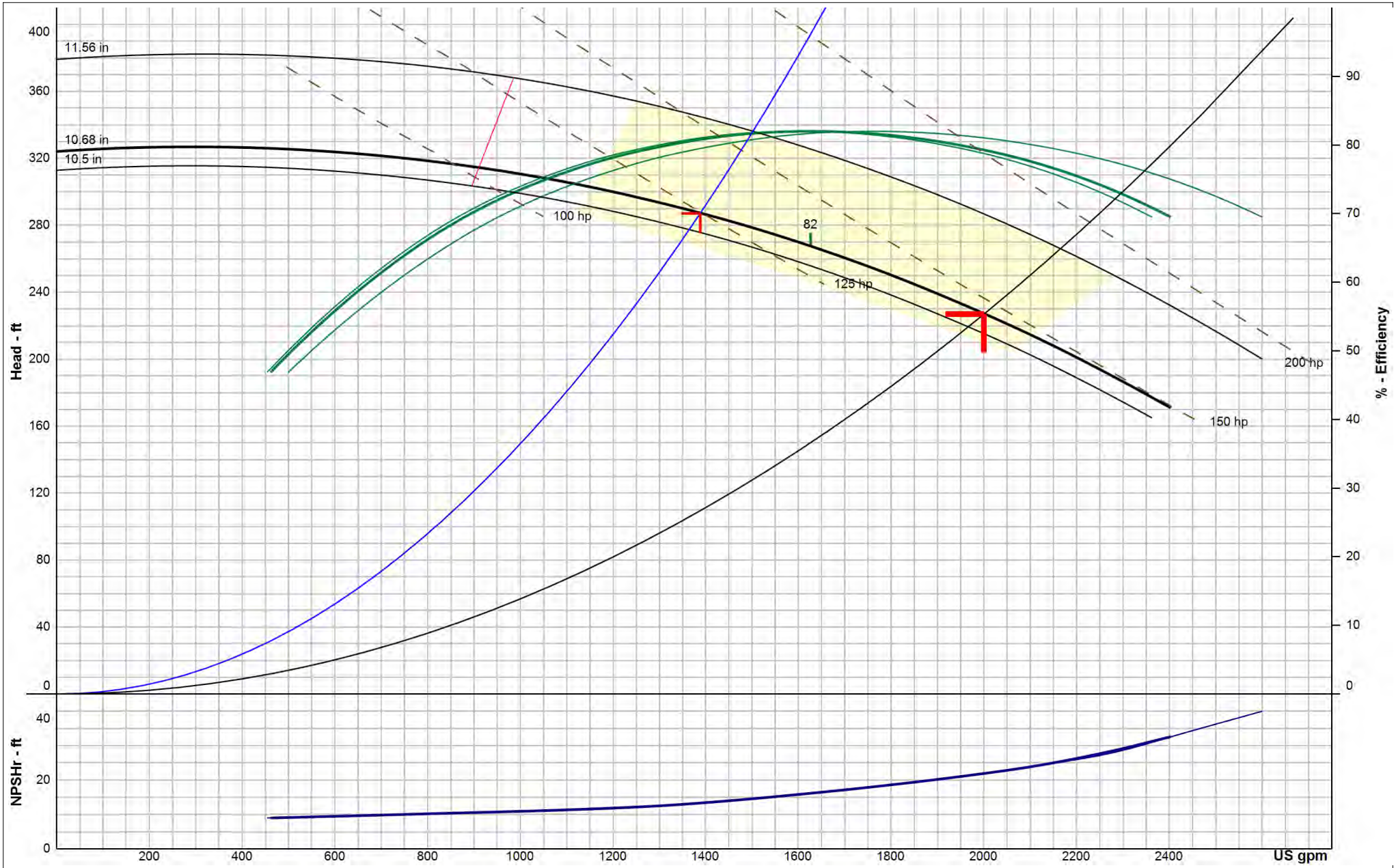
Summary

Home Watershed:	21084
Debited Watersheds (gpm):	21084 (354.2),21750 (341.5)
Zone:	A
Pumping Capacity (gpm):	1388
Well Casing Depth(ft):	150
Withdrawal Source:	Groundwater
Aquifer Type:	Bedrock
Pumping Frequency:	Intermittent
Pumping Months:	1,2,3,4,5,6,7,8,9,10,11,12
Pumping Days:	7
Pumping Hrs:	24
Latitude:	42.24893400000
Longitude:	-84.37453000000
County:	Jackson
Town Range Section:	02S01W36
Location of Discharge:	POTW
Purpose:	Thermoelectric Power
Comments:	
Total Annual Withdrawal (gallons):	**732,682,783**

DISCLAIMER: The Water Withdrawal Assessment Tool is designed to estimate the likely impact of a proposed water withdrawal on nearby streams. It is not an indication of how much groundwater may be available for your use. The quantity and quality of groundwater varies greatly with depth and location. You should consult with a water resources professional or a local well driller about groundwater availability at your location.

A-3

Vertical Turbine Pump and Griswold Valve Specifications



UNLESS OTHERWISE SPECIFIED: [1] LIMITS AND PERFORMANCE BASED ON STANDARD MATERIALS. [2] PERFORMANCE SHOWN MEETS HI 14.6-2011 GRADE 1B TOLERANCES AT THE RATED CONDITION WITHIN THE SELECTION WINDOW. [3] NPSHR AT 1ST STAGE IMPELLER CENTERLINE.

Company:	Peerless Midwest, Inc.	National Pump Company	Size:	M14XHC (stages: 3)
Name:	Consumers Energy JGS Well F	Catalog: National Pump Company.60, Vers 6c200713	Speed:	1770 rpm
Date:	03/25/2021	VERT.TURB.ENCLOSED - 1800 rpm	Dia:	10.68 in
		Design Point: 2000 US gpm, 227 ft	Curve:	CVM14XHC4P6CY
		Static Head: 0 ft	Impeller:	M14XHC (1/16)

NATIONAL PUMP COMPANY
A GORMAN-RUPP COMPANY

Pump Data Sheet - National Pump Company

Company: Peerless Midwest, Inc.
Name: Consumers Energy JGS Well Pump
Date: 10/19/2020

Pump:

Size:	M14XHC (stages: 3)	Dimensions:	
Type:	VERT.TURB.ENCLOSEI	Suction:	---
Synch Speed:	1800 rpm	Discharge:	---
Dia:	10.68 in	Vertical Turbine:	
Curve:	CVM14XHC4P6CY	Eye Area:	26.3 in²
Impeller:	M14XHC (1/16)	Bowl Size:	14.1 in
Specific Speeds:	Ns: 2300	Max Lateral:	1.13 in
	Nss: 8500	Thrust K Factor:	11.9 lb/ft

Search Criteria:

Flow:	2000 US gpm	Near Miss:	---
Head:	225 ft	Static Head:	0 ft

Pump Selection Warnings:

None

Fluid:

Name:	Water		
SG:	1	Vapor Pressure:	0.256 psi a
Density:	62.4 lb/ft³	Atm Pressure:	14.7 psi a
Viscosity:	1.1 cP		
Temperature:	60 °F	Margin Ratio:	1

Pump Limits:

Temperature:	180 °F	Sphere Size:	0.64 in
Wkg Pressure:	310 psi g	Power:	652 hp

Motor:

Standard:	NEMA	Size:	150 hp
Enclosure:	WP-I	Speed:	1800 rpm
Frame:	444		
Sizing Criteria:	Max Power on Design Curve		

--- Duty Point ---

Flow:	2000 US gpm
Head:	227 ft
Eff:	79.2%
Power:	145 hp
NPSHr:	22 ft
Speed:	1770 rpm

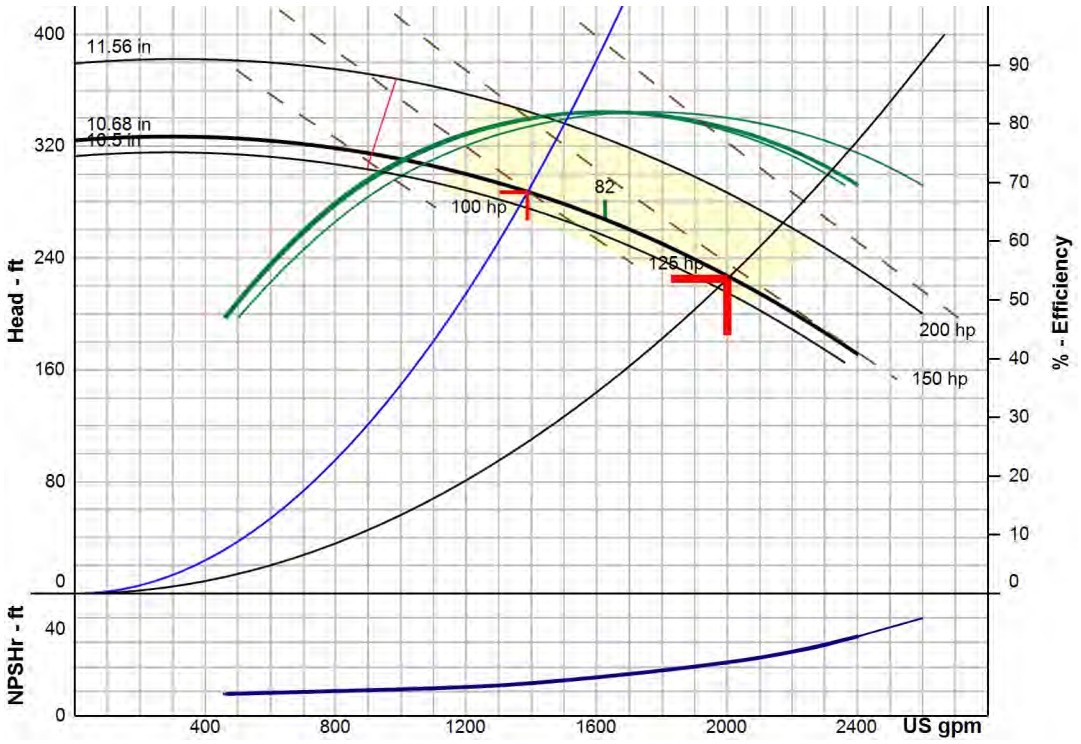
--- Design Curve ---

Shutoff Head:	324 ft
Shutoff dP:	140 psi
Min Flow:	911 US gpm

BEP: 82% @ 1626 US gpm
NOL Power:
149 hp @ 2402 US gpm

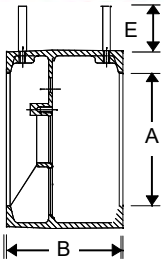
--- Max Curve ---

Max Power:
189 hp @ 2600 US gpm



Operating Points:

Data Point	Speed	Flow	Head	NPSHr	Efficiency	Power	Min Flow
	rpm	US gpm	ft	ft	%	hp	US gpm
Primary	1770	2000	227	22	79.2	145	911
1	1770	1388	287	13.4	80.7	125	911

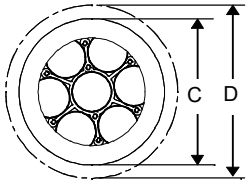


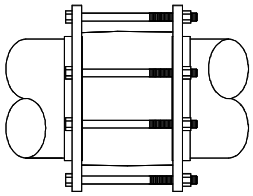
CLASS 150 WAFER

SPECIFICATIONS

PSI/Temperature Rating: 360 PSI / 275º F
Cartridge: AISI Type 304 stainless steel
AISI Type 17-7 PH stainless steel spring
Body Material: Ductile Iron ASTM A536 GR60-40-18,
Body Tappings: 1/4" NPT with P/T test valves
Assembly: Valve comes fully assembled. Pressure and Temperature port extensions are shipped loose.

Flanges: *Wafer valves are compatible with ANSI B 16.5-1968 150 lb. steel flanges and ANSI B 16.1-1967 125 lb cast iron flanges.*





DIMENSIONS & WEIGHTS (NOMINAL)

A LINE SIZE	MODEL NO.	B (+/-.03)	C (+/-.06)	D REF ONLY FLG. DIA.	E	STUDS[1] (SUPPLIED BY GRISWOLD)		WEIGHT (LBS.)
						QTY	SIZE	
2-1/2 / 3[2]	329_	6.75	4.62	7.50	5.50	4	5/8	17
4	332_	7.75	6.88	9.00	5.50	8	5/8	33
6	334_	7.25	8.62	11.00	5.50	8	3/4	42
8	337_	7.25	10.88	13.50	5.50	8	3/4	57
10	368_	8.00	13.44	16.00	5.50	12	7/8	93
12	369_	8.00	16.00	19.00	5.50	12	7/8	137
14	339_	8.00	17.63	21.00	5.50	12	1	177
16[3]	384_	9.50	20.12	23.50	5.50	16	1	291
18	385_	9.50	21.50	25.00	5.50	16	1-1/8	405
20	338_	11.00	23.88	27.50	5.50	20	1-1/8	520
24	386_	11.00	28.12	32.00	5.50	20	1-1/4	896

MODEL NUMBER SELECTION[4]

3 _ _ _ _ _ _

Select a size (2-1/2 or 3=29, 4=32, 6=34, 8=37, 10=68, 12=69, 14=39, 16=84, 18=85, 20=38, 24=86)

Select a PSID control range (STD: 1=1-20 or 4-20, 2=2-32 or 8-32, 4=4-57, 8=8-128; HI-FLOW: 3=3-18, 5=5-32, 7=7.5-32)

Insert "A" for pressure taps, "B" for pressure/temperature taps

T=Optional 3"x3" Aluminum Hanging I.D. Tag

NOTES

[1] Plated Steel Studs and Nuts are supplied by Griswold.
[2] Valve compatible with 2-1/2" and 3" ANSI flanges. Class 150 Only.
[3] 16" and larger are supplied with an eyebolt for lifting.
[4] Model no. and flow rate are indicated on label affixed to body.

1700 Barranca Parkway, Irvine, CA 92606
(949) 559-6000 Fax (949) 559-6088
www.GriswoldControls.com

GRISWOLD CONTROLS
A FlowCon International/Griswold Controls LLC. Company

GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE December 20, 2021 19131361

TO Ms. Rachel Proctor
Consumers Energy

CC

FROM Kate Richards **EMAIL Krichards@golder.com**

ATTACHMENT B: GROUNDWATER MODELLING REPORT

1.0 INTRODUCTION

This memorandum summarizes the groundwater modeling effort to evaluate the potential effects of a proposed high-capacity groundwater withdrawal at the Jackson Generating Station (JGS) in Jackson, Michigan. To reduce reliance on the City of Jackson municipal water supply, Consumers Energy Company (CEC) constructed a new water supply well (well PW-1) in June 2020, registering the well at a maximum withdrawal rate of 2 million gallons per day (MGD). The well became operational on April 26, 2021. The permit application seeks to increase the withdrawal to monthly volumes ranging between 60 million and 124 million gallons (rates of 2 to 4 MGD), and to construct up to two additional supply wells (wells PW-2 and PW-3).

In support of this permit application to increase the withdrawal beyond 2 MGD, a seven-layer, 272-square mile groundwater model was prepared to evaluate potential effects of the withdrawal. This memorandum describes the regional hydrologic basis for the model, emphasizing the hydrogeologic conditions in the immediate vicinity of the proposed withdrawal.

Since CEC has historically purchased municipal water (groundwater) from the City of Jackson, this evaluation assumes that the new JGS withdrawal is complemented by reductions in the City's withdrawals that have averaged approximately 7.0 MGD for the past 23 years. To best predict and illustrate the hydrologic effects of the proposed withdrawal:

- The 1.4 MGD average withdrawal from JGS well PW-1 (since April 2021) is conceptualized as replacing water that would otherwise have been purchased from the City. Therefore, the 1.4 MGD withdrawal at JGS results in a corresponding 1.4 MGD reduction in water withdrawn by the City of Jackson. During the last 5 years (2016 to 2020), JGS has annually purchased 549 million gallons of water (average rate: 1.5 MGD) from the City of Jackson, or about 21% of the municipal supply. It is therefore reasonable to consider the 1.4 MGD withdrawn at JGS well PW-1 since April 2021 is water that would otherwise have been purchased from the City. Therefore the "baseline" model condition is a 1.4 MGD withdrawal from JGS well PW-1, and a 5.8

Golder Associates Inc.
15851 South US 27, Suite 50 Lansing, Michigan, USA 48906 T: +1 517 482-2262 +1 517 482-2460

MGD withdrawal evenly distributed across the 16 City of Jackson wells (1.4 MGD less than the City's recent average 7.2 MGD withdrawal[1]).

- An ***additional*** 1.36 MGD withdrawal from JGS well PW-1 was modeled as an illustration of future hydrologic conditions if the maximum monthly permitted volumes were withdrawn by JGS over the course of a year, which is 2.76 MGD (Table 2, Section 2(b)). Because CEC is projecting increased use of JGS, in the absence of this Permit it is likely that the City of Jackson would need to increase its withdrawal to meet JGS demand; but it is unclear how much it would increase. Therefore, instead of assuming that the full 1.36 MGD would reduce the City's withdrawal rate by an additional 1.36 MGD, the model assigns that only the City's withdrawal will decrease by only one-half of the additional withdrawal (0.68 MGD).

Hydrologic monitoring has been ongoing since May 2020 to evaluate the hydrologic effects of the City of Jackson withdrawals and the new JGS well PW-1 withdrawal. Five onsite observation wells, and 11 off-site private residential and commercial wells, have been instrumented to monitor groundwater withdrawals by the City and the JGS well. An aquifer test of well PW-1 was completed in July 2021 to evaluate hydraulic parameters and to generate calibration target data for the groundwater flow model.

The groundwater model illustrates the hydrologic effects of two scenarios on all layers of the groundwater flow system:

1) A current conceptualization of the flow system established since the commissioning of well PW-1 in April – withdrawing an average of 1.4 MGD, less than the registered 2 MGD – and assuming that the City of Jackson is pumping 1.4 MGD less than their 7.2 MGD average (5.8 MGD), distributed evenly across its wellfields.

2) A future conceptualization of the groundwater flow system established by pumping well PW-1 at an long-term average rate of an additional 1.36 MGD (total 2.76 MGD), equal to the annual average maximum withdrawal requested in the permit application; but reducing withdrawals from the City wellfields by only one-half of that rate, or 0.68 MGD less than the baseline 5.8 MGD scenario (total withdrawal of 5.12 MGD).

2.0 CONCEPTUAL MODEL OF GROUNDWATER AND SURFACE WATER SYSTEMS

Sections 4.1 through 4.3 of the Permit Application summarize the hydrology, stratigraphy, and hydrogeology of the JGS site. The following section summarizes the regional groundwater and surface water setting of the Jackson area, specifically in the area selected as the model domain.

2.1 Model Domain

The model domain encompasses a 272-square mile area (16.5 miles by 16.5 miles) approximately centered on the JGS Site. The domain was selected to include the zone of influence of the proposed JGS supply wells and City of Jackson wellfields, and to extend as far as the Marshall sandstone recharge area in southern Jackson County. The domain is located entirely within Jackson County (Figure B-1).

[1] The 23-year (1998-2020) average withdrawal rate reported to EGLE by the City of Jackson is 4,830 GPM (6.96 MGD). However, a recent average withdrawal rate (2015-2020), corresponding to the period of time when CEC has operated JGS, is 5,033 GPM (7.25 MGD). Therefore, an average withdrawal rate of 5,000 GPM (7.2 MGD) was selected as representing the City of Jackson's current average withdrawal rate.

The majority of the domain is located within the Upper Grand River watershed; a small area in the southwest is within the Kalamazoo River watershed, and a small area in the southeast is within the River Raisin watershed (Figure B-1). The topography of the domain ranges from approximately 1,100 ft amsl in its southern extent, to around 905 ft amsl where the Grand River and Sandstone Creek (a tributary of the Grand River) flow north out of the domain (Figure B-2).

2.2 Geologic Setting

The land surface across the entire model domain is overlain by glacial sediments generally less than 200 feet thick[2] . Beneath the glacial overburden are the Michigan Basin bedrock units of the Saginaw, Parma, Bayport, Michigan, Marshall, and Coldwater formations, in order from youngest to oldest. The bedrock units dip to the north, toward the center of the Michigan Basin. In the northern portion of the domain, the Saginaw formation is the uppermost bedrock unit in the sequence. In the southern portion of the domain, the Marshall formation subcrops directly below the glacial overburden (Figure B-3).

The Saginaw formation consists of an upper sandstone aquifer, and a lower confining unit composed primarily of limestone and shale. In the northern portion of the domain, the Saginaw aquifer is generally in hydraulic connection with the glacial overburden; it is used for residential supplies, but not sufficiently thick in Jackson County for high-capacity withdrawals. The Parma sandstone aquifer underlies the Saginaw confining unit, supplying water for many private wells, but does not support commercial production wells. The Bayport limestone aquifer can be interbedded with the Parma sandstone, and is also not used for high-capacity withdrawals[3]. The Michigan formation is generally considered a confining unit and is difficult to distinguish from the overlying Bayport formation. As discussed in Section 4 of the Permit Application, the Michigan appears to be thin or absent near the project site, although it is mapped as present within the model domain.

The Marshall sandstone aquifer is the only regional unit that can store and transmit commercial quantities of water. The JGS supply well, the City of Jackson, Summit Township, and Leoni Township draw water from the Marshall. Locally, the Marshall is approximately 200 feet thick and extends to approximately 420 feet below grade at the project site. The Marshall is underlain by the Coldwater shale, a regional aquiclude, that bounds the base of freshwater resources.

2.3 Groundwater Setting

Regionally, the Jackson area is a recharge zone for both the Saginaw and Marshall bedrock aquifers. Groundwater flow in the Marshall aquifer is northerly, from the recharge area in southern Jackson County, towards the City of Lansing. Discharge from the Marshall aquifer occurs at the Saginaw Lowlands (near Saginaw Bay), and the Michigan lowlands in Ottawa County. Recharge to the Saginaw aquifer occurs generally near and north of the JGS site, with groundwater also flowing north toward Lansing. The bedrock units are recharged from overlying saturated glacial materials.

[2] Olcott, P.G. (1992). Groundwater Atlas of the United States, Iowa, Michigan, Minnesota, Wisconsin. U.S. Geologic Survey HA-730 J

[3] Westjohn, D.B. and Weaver, T.L. (1996). Hydrogeologic Framework of Mississippian Rocks in the Central Lower Peninsula of Michigan. U.S. Geological Survey, Water-Resources Investigations Report 94-4246.

Recharge to the glacial overburden within the model domain is generally high, ranging between 9 and 11 inches per year south of Jackson; to around 5 to 8 inches per year northwest of Jackson[4] (Figure B-4). Recharge to the overburden can flow laterally to the Grand River and tributaries, but also vertically to porous and fractured bedrock subcropping below the overburden.

Groundwater at the project site is conceptualized as two distinct groundwater units, separated by the Saginaw confining unit (Section 4, Permit Application). Above the Saginaw confining unit, groundwater in the overburden and Saginaw sandstone is generally between 950 and 960 ft amsl in the vicinity of JGS. At the project site, the majority of the overburden consists of clay till which physically and hydraulically separates perched wetlands and surface water from the Saginaw aquifer. Below the Saginaw confining unit, groundwater in the Parma, Bayport, Michigan (if present) and Marshall units are in hydraulic communication, with water levels generally between 920 and 930 ft amsl near JGS.

2.4 Surface Water

The majority of the model domain is located in the Upper Grand River watershed (Figure B-1). The Grand River flows southeast to northwest into downtown Jackson about 1 to 1.5 miles southwest of JGS. A major tributary flows from Center Lake into the Grand River about 1.5 miles south-southeast of JGS, near the US-127 and South Street interchange. There are no perennial streams or creeks within 1 mile of JGS, likely due in part to the presence of municipal stormwater infrastructure.

2.5 Wetlands

Numerous wetlands are present in the vicinity of Jackson, particularly adjacent to the Grand River and its tributaries south and southeast of Jackson. Wetlands along the Grand River are generally present in the glacial outwash and alluvial deposits associated with the river, and are assumed to be in hydraulic communication with the river. The surface elevation at these wetlands is approximately 930 to 935 feet amsl.

Within a 1-mile radius of JGS, perched wetlands are present at an elevation of around 955 to 965 ft amsl, or 20 to 30 feet above the level of the wetlands along the Grand River. The nearest wetland to JGS, along and east of Roberts Street, has a surface elevation of approximately 955 ft amsl, as measured at observation well OW-4s. As discussed in Section 4.2.1, there is a steep downward hydraulic gradient across the glacial overburden.

2.6 Aquifer Parameters

A July 2021 constant-rate aquifer test is the basis for aquifer parameters. Transmissivity of the Marshall aquifer was estimated to be between 8,000 and 9,000 ft^2/d. Regionally, transmissivity has been reported to range between 7,500 and 29,000 ft^2/d by USGS[5]. Storativity was estimated to range between 1×10^{-4} and 3×10^{-4} (Section 4.3.4).

[4] Estimate of Annual Groundwater Recharge, Edition 1.0 (August 18, 2005). Groundwater Inventory and Map Project, Water Bureau - Michigan Department of Environmental Quality, USGS - Michigan Water Science Center and Michigan State University - Institute of Water Research, RS&GIS and Biosystems and Agricultural Engineering

[3] Feinstein, D.T., Hunt, R.J., and Reeves, H.W., 2010, Regional groundwater-flow model of the Lake Michigan Basin in support of Great Lakes Basin water availability and use studies: U.S. Geological Survey Scientific Investigations Report 2010–5109, 379 p.

[5] Westjohn, D.B. and Weaver, T.L. (1996). Hydrogeologic Framework of Mississippian Rocks in the Central Lower Peninsula of Michigan. U.S. Geological Survey, Water Resources Investigation Report 94-4246. 46 p.

3.0 GROUNDWATER MODEL

The groundwater flow model is constructed using the MODFLOW-USG (UnStructured Grid)[3]. MODFLOW-USG was chosen due to its flexibility of grid design and ability to simulate pinch-out layers and provide the fine grid resolution required to accurately simulate water level elevations around pumping wells. The model domain encompasses the City of Jackson and its immediate surroundings for a total area of approximately 272 square miles.

3.1 Finite-Difference Grid

The model grid consists of seven layers with 19,254 nodes per layer. A quadtree refinement is used around the supply and observation wells as well as the City of Jackson supply wells. Grid cells range in size from 1000 feet by 1000 feet for the parent grid to 125 feet by 125 feet in the area of highest refinement, which encompasses the JGS supply well (PW-1) and all observation wells used to interpret the pump test (Figure B-5).

A seven-layer geologic model was developed using LeapFrog[7]software. The seven layers were defined based on their physical and hydrogeologic properties:

- Layer 1, Glacial overburden, represents the full range of glacial sediments and textures overlying bedrock throughout the study area.
- Layer 2, the Saginaw aquifer, is a transmissive sandstone bedrock unit widely used for residential water supplies.
- Layer 3, the Saginaw confining unit, is characterized by low horizontal and vertical hydraulic conductivity layer and is simulated as a confining unit.
- Layer 4, the Parma sandstone, is poorly transmissive but widely used for low-capacity residential supplies.
- Layer 5 combines the Bayport Limestone and Michigan formation. Although USGS combines the Parma and Bayport formations[5], the Bayport and Michigan were combined as a single layer for the model because no observation points are completed in the Bayport or Michigan, but several are completed in the Parma sandstone (Layer 4). It is also inferred that the Michigan formation is not locally present.
- Layer 6, the Marshall Sandstone, is highly transmissive and regionally utilized for high-capacity withdrawals.
- Layer 7, the Coldwater Shale, is a regional aquitard that defines the base of the model as a no-flow boundary.

The top surface of layer 1 (glacial overburden) was derived from a United States Geological Survey (USGS) digital elevation model (DEM), as shown on Figure B-6. The bottom surface of layer 1 (the contact between the glacial overburden and the uppermost bedrock unit) was derived from importing the bedrock surface elevation of 3,772 Michigan EGLE Water Well Records and interpolating the depths across the domain. The USGS Regional Groundwater-Flow Model of the Lake Michigan Basin[3] was used to interpolate the top and bottom of the Marshall

[6] Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013, MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

[7] LeapFrog Geo v5.1.1, Copyright © 2020 Seequent Ltd.

Sandstone (Layer 6). Finally, 96 water well records local to JGS were used to define contacts between the Saginaw aquifer, Saginaw confining unit, Parma sandstone, Bayport limestone and Michigan formation, and the Marshall aquifer (Layers 2, 3, 4, 5, and 6).

The geologic model cross-section is shown on Figure B-3. The hydrostratigraphic units pinch out to the south as shown on Figure B-7 in cross-sectional view and on Figure B-8 in map view. The layer pinch outs were simulated in the model allowing recharge to move from the overburden directly to the Marshall Sandstone in the southern portion of the model, as shown on Figure B-8. Figure B-9 shows the interpolated layer thickness for each hydrostatigraphic unit, except the Coldwater Shale (layer 7), which was assigned a uniform thickness of 50 feet across the base of the model.

3.2 Constant Head Boundary Conditions

Flow into or out of the model domain was simulated using the Constant Head Boundary (CHB) package. Constant head boundaries were simulated along the northern and southern boundary in model layers 1 and 6, representing the Overburden and Marshall Sandstone (Figures B-10 and B-11). The constant head boundaries simulated in model layer 1 were calculated using a combination of the simulated water level elevations from the USGS Lake Michigan Basin Model[3] and ground surface elevations[7] at surface water locations along the model boundaries. The USGS Lake Michigan Basin Model water level elevations were compared to surface elevations and were found to be higher than the stream elevations; to correct the elevation discrepancy, the elevation difference was subtracted from the USGS Lake Michigan Basin Model water level elevations and the resulting water level elevations were assigned as constant head boundaries in model layer 1 as shown on Figure B-11. The southern constant head boundary assigned to model layer 1, Overburden, was also assigned to model layer 6, Marshall Sandstone, as these hydrostratigraphic layers are in contact in the southern portion of the model. The northern constant head boundary assigned to model layer 6 was determined during calibration, as shown on Figure B-11. Additional northern boundary conditions were assigned to model layers to allow water to flow north and out the model boundary as needed.

3.3 Surface Water and Wetlands

The River (RIV) package of MODFLOW-USG was used to simulate surface water features within the model domain. Figure B-12 show the simulated river boundary condition and the rivers, creeks, and ponds. Wetlands were not directly simulated in the groundwater flow model. However, wetlands are indirectly simulated by allowing the model to flood in lowland areas. The RIV package simulates flow in or out of the groundwater to surface water and does not simulate flow within the surface water (river and creeks). The river is primarily gaining from groundwater and acts like a drain to the Overburden, model layer 1. The river state was estimated from the topography and set at 1 foot below the USGS DEM7) elevations. The river bottom was set to be 1 foot below the river surface. The river width was set to 200 feet with a river-bed thickness was set to 1 foot. The hydraulic conductivity was adjusted during calibration. The calibrated hydraulic conductivity of approximately 499 ft/day resulted in the best match to observed water level elevations.

3.4 Pumping Wells

Groundwater wells were simulated using the Connected Linear Network package (CLN). The CLN package can simulate multi-node wells, or wells that are open to multiple layers. This process simulates water withdrawn from multiple groundwater cells and calculates the head in the CLN. The CLN package was chosen to accurately simulate the wells in the study area that withdraw water from multiple hydrostratigraphic units, as summarized in

Table 1. The City of Jackson municipal well fields, the new JGS supply well, and observation wells were simulated using the CLN package, as shown on Figure B-13.

The City of Jackson operates four production wells at the Ella Sharp Park wellfield and 12 production wells at the Mansion Street wellfield to meet the City's water needs. The wells primarily withdraw water from the Marshall sandstone (model layer 6). An annual average withdrawal of 7.2 MGD was assigned to the City of Jackson based on the 23-year (1998 to 2020) average withdrawal rate of 6.96 MGD, but weighting the last 6 years (2015 to 2020) during which time CEC has operated JGS, and during which municipal water production averaged 7.25 MGD. Given the City of Jackson well field operations and monthly water use is unknown, the average production rate was simulated by dividing 5,000 GPM (7.2 MGD) equally between the 16 extraction wells it maintains at the Ella Sharp Park and Mansion Street wellfields. Pumping from individual residential wells were not simulated due to their low pumping rates.

Table 1: Supply Well and Observation Well Construction

Well Name	Primary Model Layers	Top of Open Interval	Bottom of Open Interval
PW-1 (Supply Well)	6	778.98	604.98
OW-2s	4	842.58	794.58
OW-2d	6	741.80	649.80
OW-4D	1	921.85	916.85
OW-4S	1	954.06	949.06
OW-3	6	746.85	544.85
2602 Chapin	2	901.65	839.65
334 Watts	2	898.35	862.35
3141 Sparks	4	855.55	799.55
3150 Mott	2	944.76	907.76
429 S Dettman	2 - 4	899.42	793.42
226 Briscoe	2	918.22	886.22
3213 Perlman	4	889.89	784.89
539 Sheridan	2 - 4	908.33	793.33
357 Sheridan	2	910.68	880.68
323 Seneca	3 - 4	885.16	779.16
3500 Ann Arbor	3 - 6	892.47	720.47

3.4.1 Recharge

The Recharge (RCH) package was used to simulate recharge. A constant recharge rate was applied to the Overburden, model layer 1 (Figure B-4). Recharge was adjusted during calibration within the range established in the conceptual model. The calibrated recharge rate of approximately 5.8 inches per year resulted in the best match to observed water level elevations.

4.0 MODEL CALIBRATION AND RESULTS

Model calibration is the process of adjusting the model parameters (hydraulic properties and boundary conditions) within observed or reasonable ranges based on the conceptual model of the site, until the model reasonably

replicates observed hydrogeologic conditions. Upon model construction and prior to calibration, the model contained initial estimates for hydraulic conductivity, specific storage, specific yield and porosity, river conductance, recharge, and constant head boundary conditions. During calibration, model properties were adjusted within reasonable parameter value bounds established during the conceptual model development. The model was calibrated to steady-state conditions, water level elevations prior to the pump test, and to transient conditions measured during the pumping test at JGS supply well PW-1. The City of Jackson wellfields were modelled as withdrawing 5,000 GPM (7.2 MGD) during both the steady-state and the transient calibration period. The JGS supply well withdrew no water during the steady-state calibration period and withdrew 1,388 GPM (2 MGD) during the transient period.

Calibration was performed to match simulated groundwater levels to observed values at 15 observation wells during the pump test period from 7/25/2021 07:30 AM to 7/27/2021 07:30 AM. Groundwater levels for the observation wells at 1-hour intervals during the pumping test were used as calibration targets for the transient model. City of Jackson pumping wells, JGS supply well PW-1, and the observation wells were simulated using the well construction data summarized above in Table 1. The calibrated model parameters are summarized in Table 2.

Table 2: Calibrated Hydraulic Parameters

Layer	Kh (ft/d)	Kv (ft/d)	Ss (1/ft)	Sy
1	12	0.012	3.00E-03	0.10
2	12	0.12	3.00E-03	0.015
3	0.001	0.001	1.00E-07	0.001
4	5	0.05	1.00E-07	0.001
5	5	0.05	1.00E-07	0.001
6	33	0.33	3.00E-07	0.001
7	0.001	0.00001	3.00E-07	0.001

Notes: Kh = horizontal hydraulic conductivity. Kv = vertical hydraulic conductivity. Ss = specific storage. Sy = specific yield.

The steady-state model calibration focused on a subset of water level elevations measured in wells representative of single hydrostratigraphic units, as summarized in Table 3. The simulated water level elevations are generally within 1.5 feet of observed values except for the residential pumping well at 3150 Mott, which is 76 feet deep and completed in the Saginaw aquifer. Figure B-14 shows the observed and simulated water level elevations for the steady-state model calibration. The root mean square error is 0.9 feet for the steady-state model calibration.

Table 3: Steady-State Calibration Targets

Well	Model Layers	Residual
PW-1 (Supply Well)	6	-1.42
OW-2s	4	-1.02
OW-2d	6	-1.05
OW-3	6	-0.69
OW-4s	1	-0.63
3150 Mott	2	-5.80
3141 Sparks	4	1.15
3213 Perlman	5	0.03

Note: Residual = [Observed Water Level] - [Simulated Water Level]

The transient model simulated the pump test and matched simulated water level elevations to observed water level elevations recorded by pressure transducers at the 16 observation wells. Table 4 summarizes the measured response of each observation well to the pump test, at the end of pumping well PW-1 at 1,388 GPM for 48 hours. Eight observation wells had less than 0.2 feet of response to the pump test, each of which are completed above the Saginaw Confining Unit. Wells screened below the Saginaw confining unit show a response during the pump test (Table 4). Figure B-15 compares the simulated drawdown to the observed at key well locations. While the model over-predicts water level elevations at wells closest to the pumping well, including OW-2d, OW-3, and OW2s, it provides a good match to the 3213 Perlman and 3141 Sparks, which are located approximately 3,600 feet from the pumping well with a maximum drawdown of approximately 8.33 feet. The transient model provides the best fit to neighborhood wells extracting groundwater from shallow aquifer units including the Parma Sandstone and Bayport/Michigan Formation (model layers 4 and 5), while overestimating drawdown at observation wells close to the JGS supply well, and north of East Michigan Avenue (323 Seneca and 3500 Ann Arbor). This calibration approach provides the best calibration where the greatest likelihood of well interference may occur.

Table 4: Well Construction and Maximum Drawdown

Well	Primary Model Layers	Distance to Pumping Well (ft)	Maximum Drawdown (ft)
PW-1 (Supply Well)	6	0	28.02
OW-2s	4	200	11.45
OW-2d	6	201	16.81
OW-3	6	505	15.47
OW-4S	1	339	<0.2
OW-4D	1	343	<0.2
2602 Chapin	2	812	<0.2
334 Watts	3	883	<0.2
3141 Sparks	4	3,405	8.32
3150 Mott	2	3,141	<0.2
226 Briscoe	2	2,896	<0.2
3213 Perlman	5	3,609	8.33
539 Sheridan	2 - 4	3,739	<0.2
357 Sheridan	2	3,872	<0.2
323 Seneca	3 - 4	4,247	3.20
3500 Ann Arbor	3 - 6	7,021	3.53

5.0 ASSESSMENT RESULTS

Two steady-state simulations were developed as part of the predictive analysis including a baseline simulation and a predictive simulation. The baseline simulation represents current condition and simulates the City of Jackson withdrawing 5.8 MGD and JGS supply well PW-1 withdrawing its baseline (April to September 2021) rate of 1.4 MGD. The predictive simulation represents future proposed conditions and simulates the City of Jackson reducing its pumping by 0.68 MGD for a rate of 5.12 MGD and JGS supply well PW-1 increasing its withdrawal rate to 2.76 MGD. Table 5 summarizes the simulated pumping rates.

Table 5: Baseline and Proposed Pumping Rates

Scenario	City of Jackson Pumping (MGD)	JGS Supply Well Pumping (MGD)
Baseline Simulation	5.8	1.4
Predictive Simulation	5.12	2.76

Baseline Simulation

The baseline simulation simulates the City of Jackson pumping wells withdrawing 5.8 MGD uniformly distributed across 16 pumping wells and the JGS supply well PW-1 withdrawing at its average usage of 1.4 MGD. The results of the baseline simulation are shown on Figures B-16 and B-17. Within the upper aquifer (model layers 1 and 2), the groundwater shows no response to the City of Jackson nor the PW-1 withdrawals, as shown on Figure B-16. Groundwater contours in the glacial mimic topography, and flowpaths are generally toward the Grand River or nearest surface water feature (Figure B-16). Groundwater flow in model layers 4, 5, and 6 is generally from the

recharge area in southern Jackson County towards the north, but is captured by and deflected towards the City of Jackson wellfields and the JGS supply well (Figure B-16).

Figure B-17 illustrates the simulated capture zones for the baseline condition within the Marshall Sandstone (model layer 6). The COJ wellfields have large capture zones within the Marshall Sandstone extending southwest toward areas where the Marshall sandstone subcrops directly below the glacial overburden. The JGS supply well capture zone extends toward the west and to the southeast, around the City of Jackson's established capture zone, as shown on Figure B-17.

Predictive Simulation

The predictive simulation simulates the City of Jackson pumping 5.12 MGD uniformly distributed across 16 pumping wells and the JGS Supply Well increasing its extraction rate by 1.4 MGD to 2.76 MGD. Similar to the preceding baseline scenario, the upper aquifer (model layers 1 and 2) do not respond to the City of Jackson or the JGS supply well withdrawals, while in the deeper aquifer units (model layers 4, 5, and 6) groundwater flows toward the City of Jackson well fields and JGS supply well (Figure B-18). Similarly, Figure B-19 shows the simulated capture zones within the Marshall Sandstone (model layer 6) for the proposed scenario. The City of Jackson wellfield capture zone generally shows little change, and the JGS capture zone extends further to the south compared to the baseline capture zone (Figure B-19). The increase in pumping at the JGS supply well coupled with the decrease in pumping in the City of Jackson wells slightly expands the capture zone of the JGS supply well, while compressing the City of Jackson capture zone (Figure B-19).

Notably, because the expanded use of JGS well PW-1 does not significantly alter the City of Jackson's capture zone, it is inferred that the municipal water quality will not be significantly altered by the proposed withdrawal.

The difference between water level elevations from the baseline conditions to the proposed scenario within the Marshall Sandstone were calculated to illustrate regional drawdown, and potential well interference, associated with the proposed withdrawal (Figure B-20). A cone of depression extends radially from JGS supply well PW-1; generally 10 feet or more of additional drawdown is expected on the parcel where PW-1 is located, and in nearby areas such as the wells at 2602 Chapin and 334 Watts (Neighborhood "A", as discussed in Attachment C); but these private wells are shallow, completed above the Saginaw confining unit. Approximately 5 to 10 feet of drawdown is anticipated in areas along and east of Dettman Avenue (Neighborhoods "B" and "D", Attachment C) where a strong hydraulic connection has been observed to private wells such as 3141 Sparks and 3213 Perlman. Less than 5 feet of drawdown is observed in areas greater than approximately 4,000 feet from well PW-1.

Conversely, because of the modeled reduction in withdrawals from the City of Jackson wellfields, water levels are expected to rise about 1 foot or less in the areas of the City of Jackson capture zone, and more than 1 foot in the immediate vicinity of the Mansion Street wellfield (Figure B-20).

6.0 MODEL LIMITATIONS

The calibrated numerical model meets the model objects to simulate proposed pumping conditions within the upper and lower aquifer units within the JGS supply well's area of influence. Assumptions made during the numerical model development include the City of Jackson withdrawal rates during the calibration period, which were estimated based on historical records and evenly distributed within the Ella Sharp and Mansion Street wellfields. In addition, the simulated hydraulic properties, such as hydraulic conductivity, specific yield, and the storage coefficient, were assumed to be homogeneous representing an average condition within each

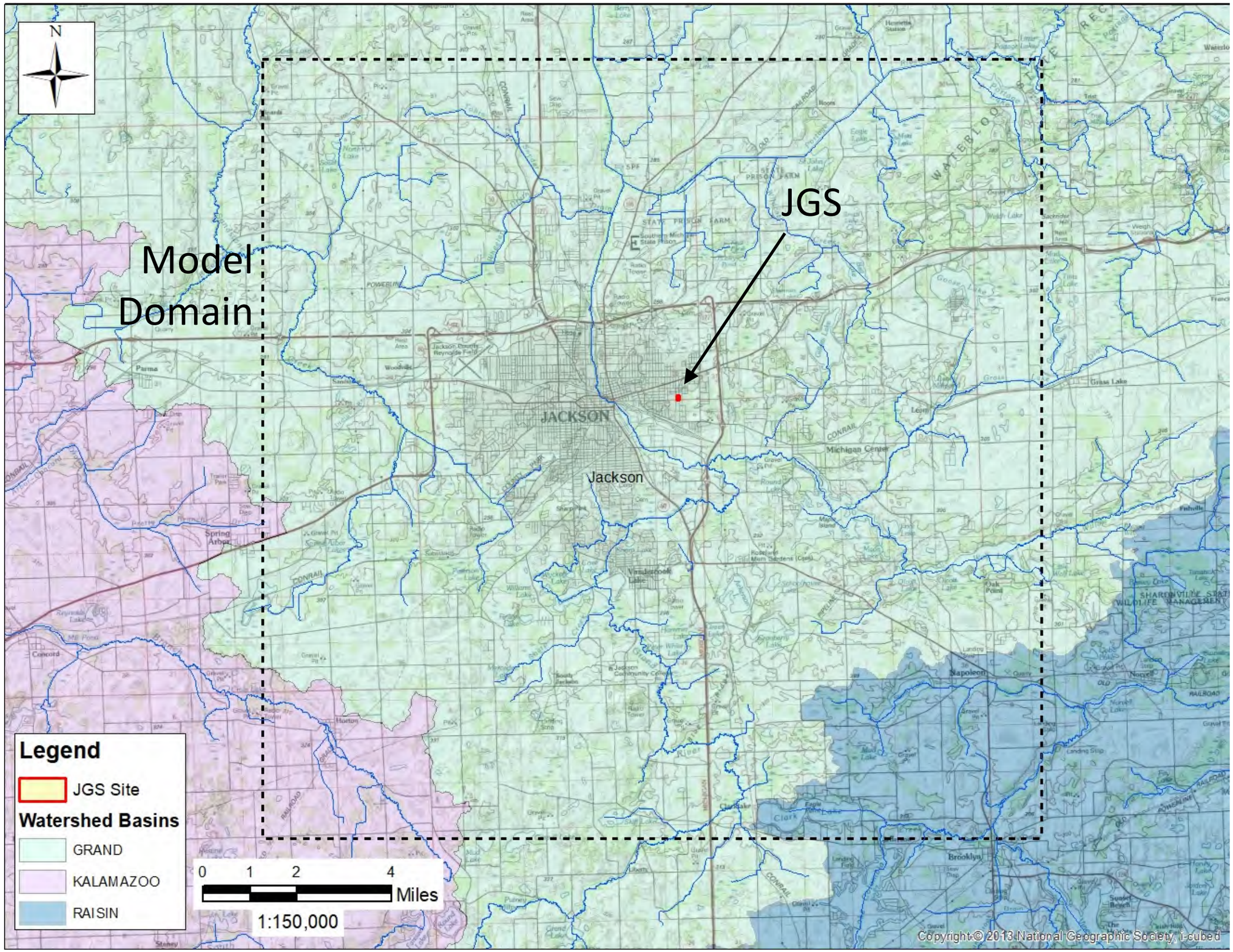
hydrostratigraphic unit, when in fact, hydraulic properties vary within the model domain. The calibrated hydraulic properties reflect the available data, and represent the conditions at and around the JGS Supply well and not the entire model domain. The numerical model is well calibrated to meet its objectives and should not be used beyond this purpose.

7.0 CONCLUSIONS

The model simulations show the increased withdrawal of 1.36 MGD at the JGS supply well result in a decrease in water level elevations with the Marshall Sandstone up to approximately 10 feet in residential areas with private wells. Alternatively, the decrease in withdrawal rates at the City of Jackson wellfields result in an increase of water level elevations of about 1 foot. The model simulations further show the capture zone for the City of Jackson is to the south and is not significantly influenced by new withdrawals at JGS. Similarly, the upper aquifer is not affected by the increased withdrawal at the JGS supply well.

ATTACHMENT B

Figures



CLIENT
CONSUMERS ENERGY COMPANY

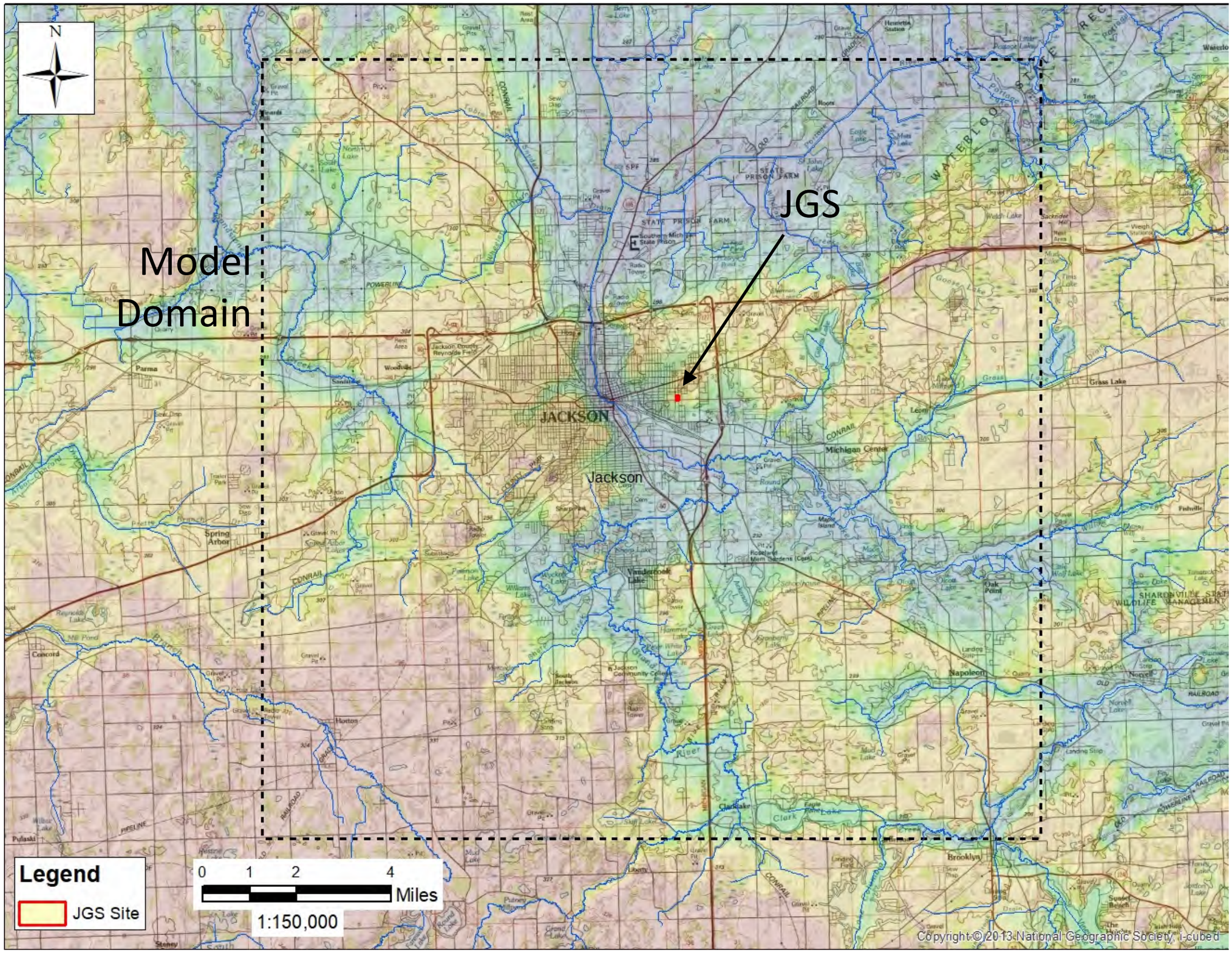
CONSULTANT
GOLDER

YYYY-MM-DD	2021-12-07
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION
ATTACHMENT B

TITLE
REGIONAL WATERSHEDS WITHIN GROUNDWATER MODEL DOMAIN

PROJECT NO. 19131361 | CONTROL | REV. | FIGURE B-1



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CONSULTANT
GOLDER

YYYY-MM-DD	2021-12-07
PREPARED	JCH
DESIGNED	JCH
REVIEWED	JW
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION
ATTACHMENT B

TITLE
REGIONAL TOPOGRAPHY AND GROUNDWATER MODEL DOMAIN

PROJECT NO.	CONTROL	REV.	FIGURE
19131361			B-2

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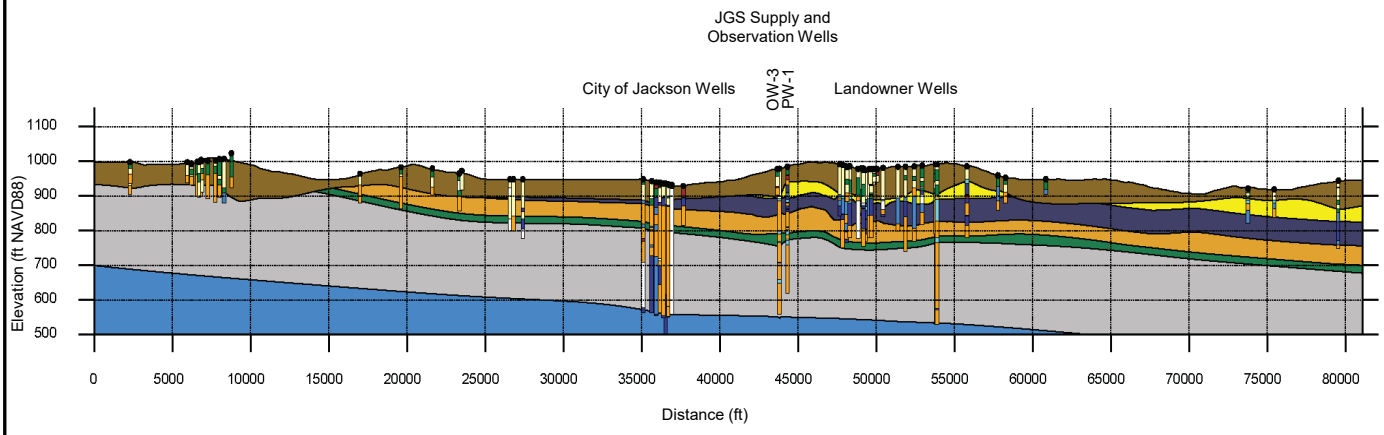
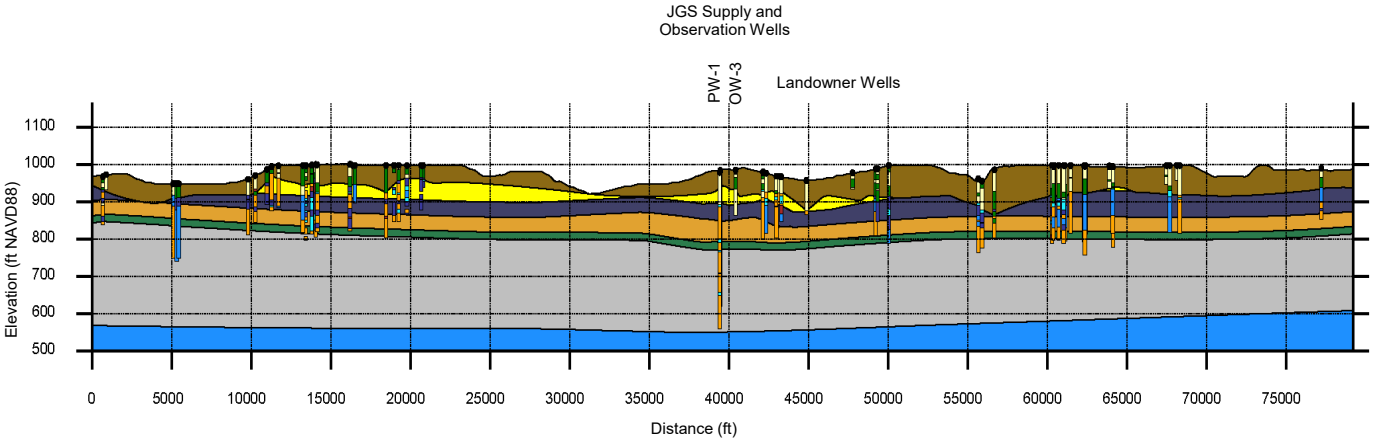
S North-South Cross-Section N



W East-West Cross-Section E



Borehole Log

- Silt and/or Clay
- Sand and/or Gravel
- Sandstone
- Limestone
- Shale
- Shale and Limestone
- Other
- No Information

Scale: 1:100,000
Vertical Exaggeration: 20x

Hydrostratigraphy

- Overburden (Glacial Material)
- Saginaw Aquifer
- Saginaw Confining Unit
- Parma Sandstone
- Bayport-Michigan
- Marshall Sandstone
- Coldwater Shale

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PROJECT
JACKSON GENERATING STATION
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MEMBER OF WSP

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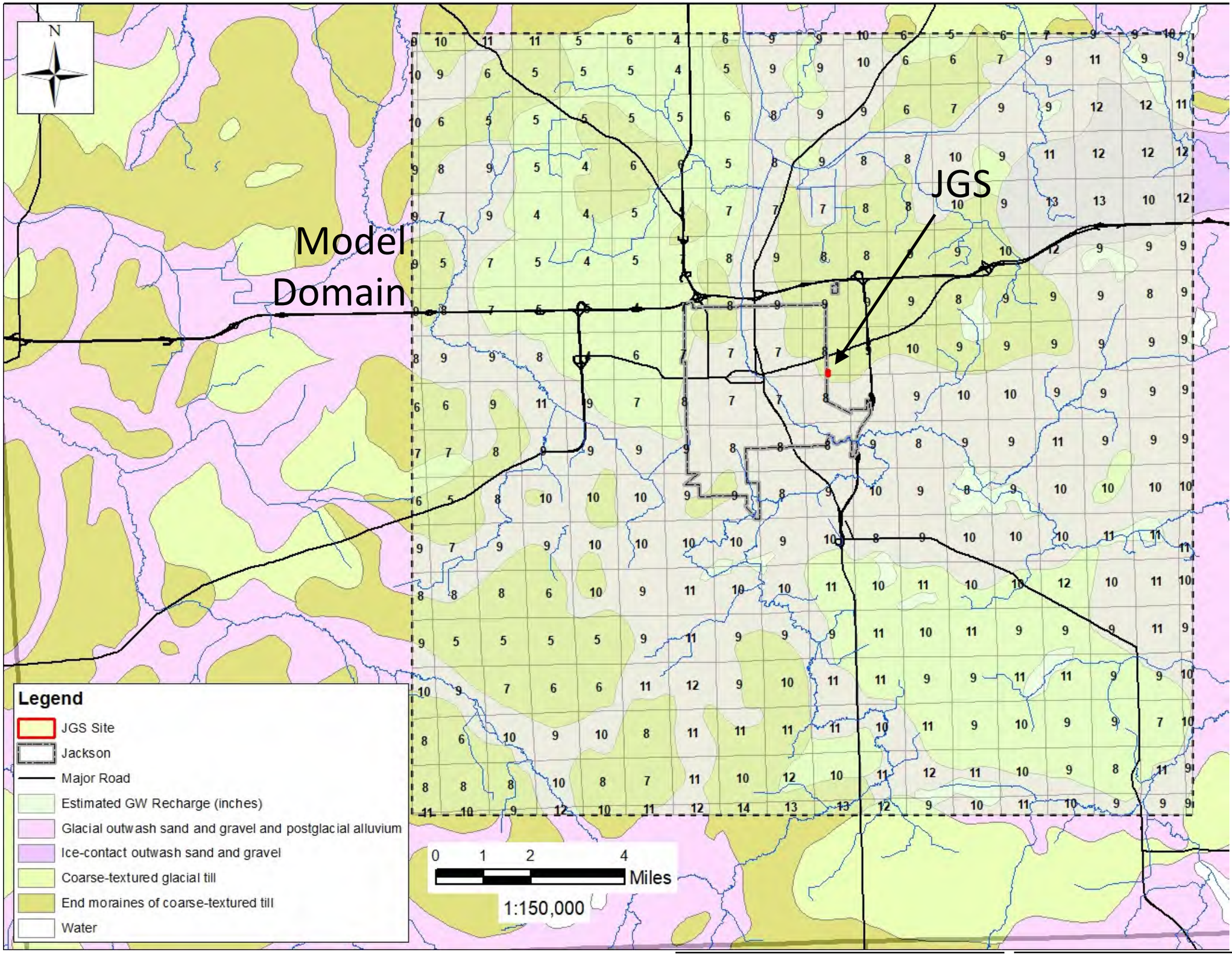
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

Title
GEOLOGIC MODEL CROSS-SECTIONS

PROJECT NO.	REV.	FIGURE
19131361	0	B-3



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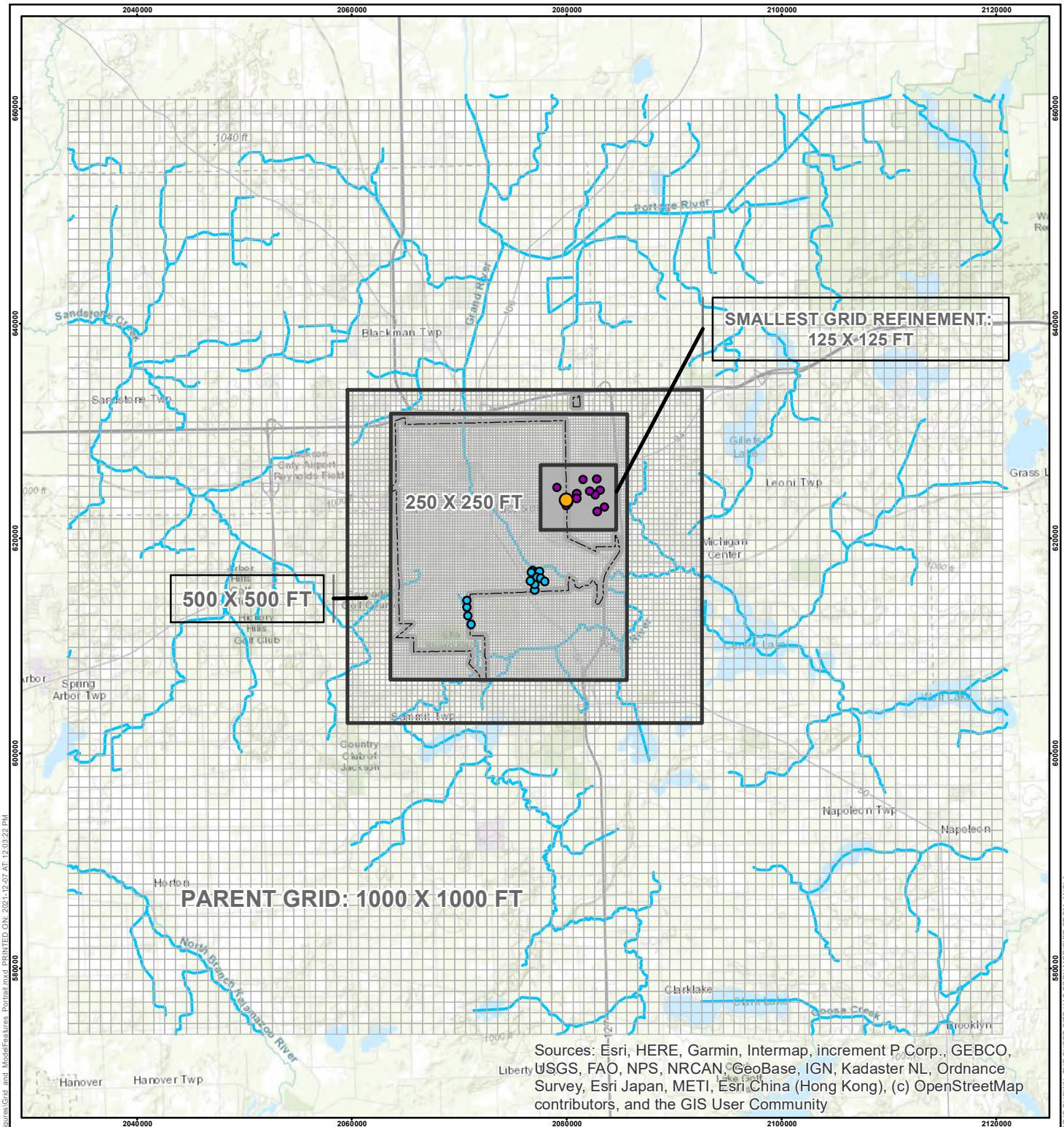
CONSULTANT
GOLDER

YYYY-MM-DD	2021-12-07
PREPARED	JCH
DESIGNED	JCH
REVIEWED	JW
APPROVED	MW

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION
ATTACHMENT B

TITLE
REGIONAL GROUNDWATER RECHARGE TO OVERBURDEN

PROJECT NO. 19131361 CONTROL REV. FIGURE B-4



- JGS Supply Well
- Observation Wells
- City of Jackson Wells
- Grid Refinement Areas
- City of Jackson
- Model Grid
- EGLE Base Flow of Michigan Streams

0 6,250 12,500
Feet

N

NOTE(S)

1. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
3. BASEFLOW OF MICHIGAN STREAMS SHAPFILE: EGLE (2017)

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PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL APPLICATION PERMIT

TITLE
GROUNDWATER FLOW MODEL GRID

CONSULTANT

YYYY-MM-DD	11-12-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361 | REV. 0 | FIGURE B-5

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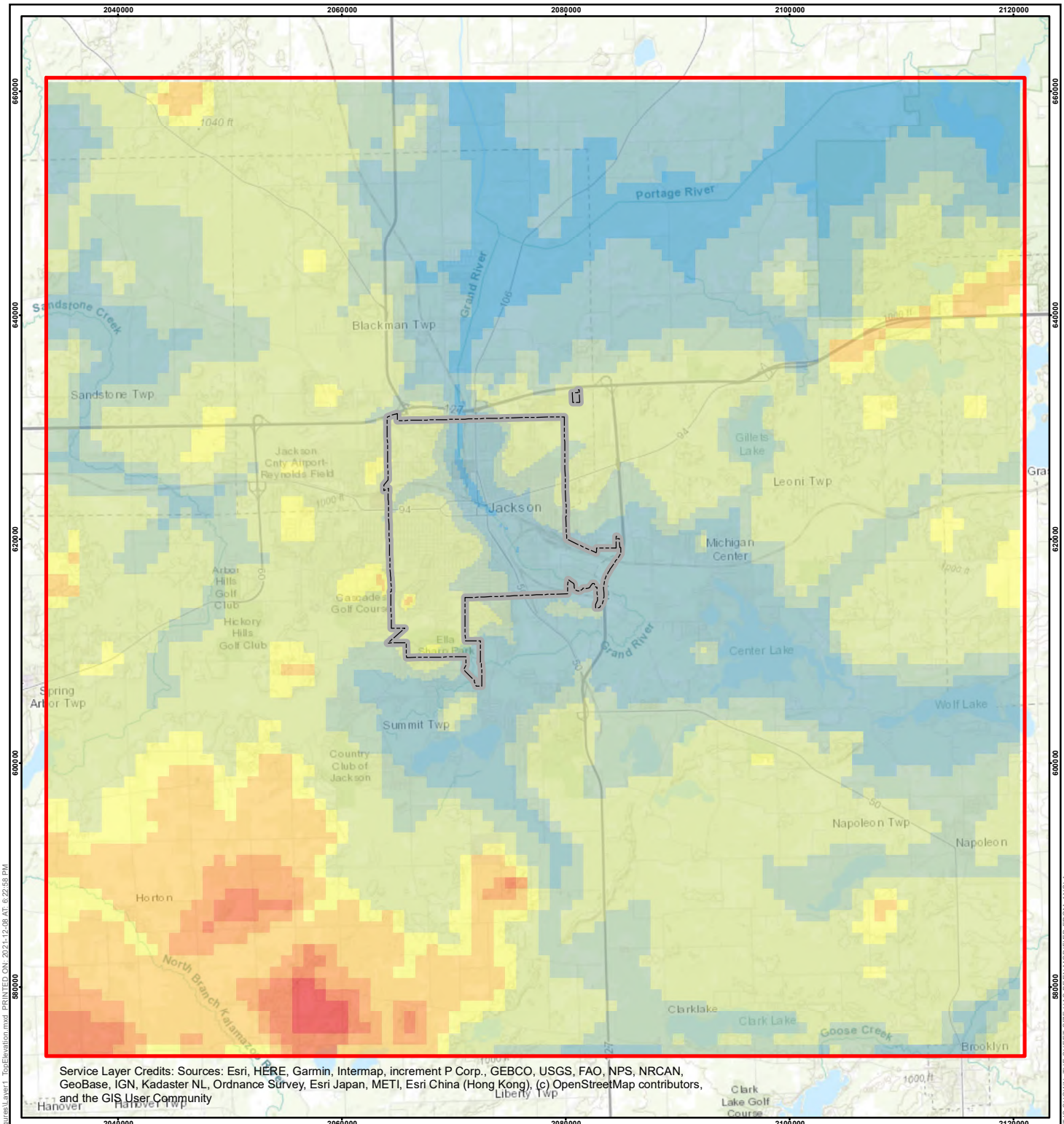

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Model Domain

City of Jackson

Layer 1 Top Elevation (ft NAVD88)

< 925	925 - 950	950 - 975	975 - 1000	1000 - 1025	1025 - 1050	1050 - 1075	1075 - 1100	> 1100

0 6,250 12,500

Feet

N

NOTE(S)

1. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

REFERENCE(S)

1. ELEVATION DERIVED FROM USGS 3DEP DIGITAL ELEVATION MODEL, ACCESSED VIA THE NATIONAL MAP WEBSITE.
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

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PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
LAYER 1 OVERBURDEN TOP ELEVATION

CONSULTANT

YYYY-MM-DD	11-12-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	####

PROJECT NO.	REV.	FIGURE
19131361	0	B-6

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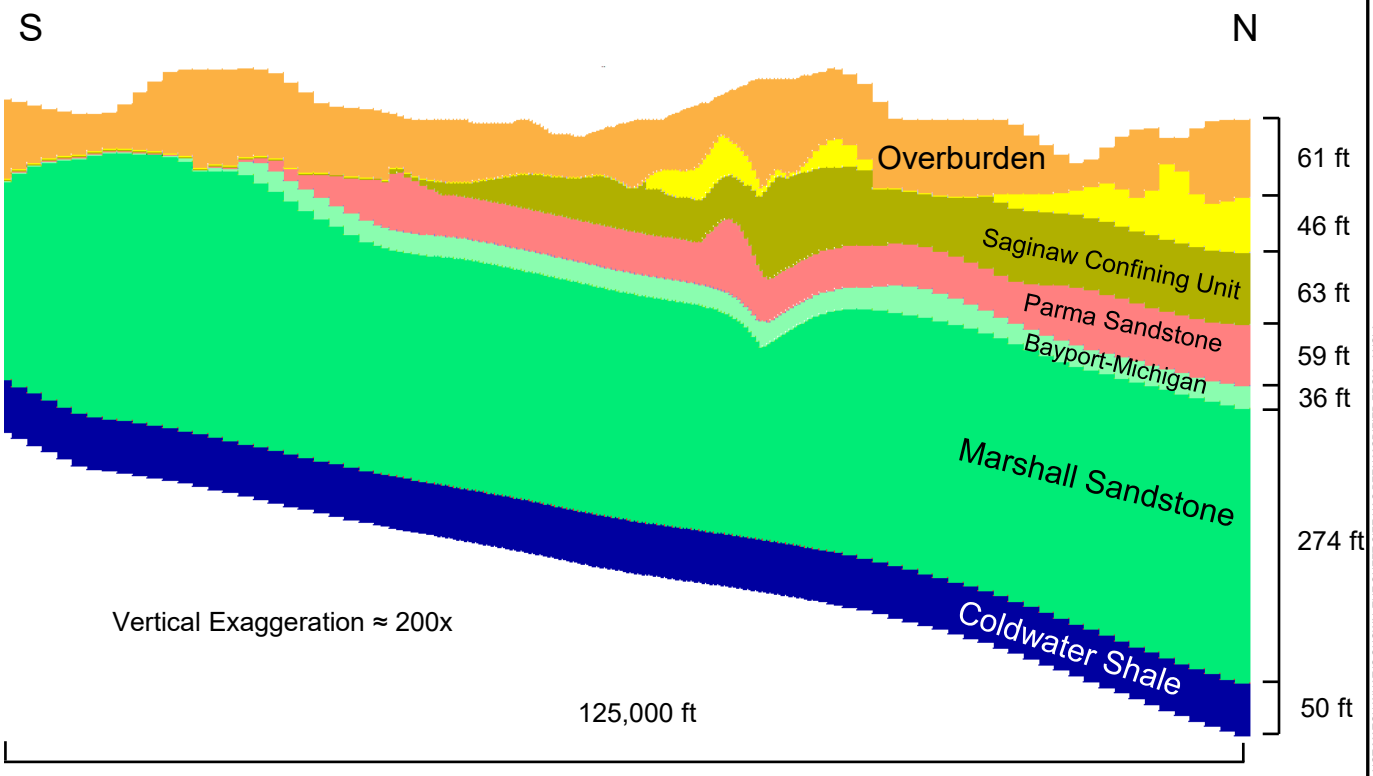
Model Layer	Hydrostratigraphic Unit
1	Overburden
2	Saginaw Aquifer
3	Saginaw Confining Unit
4	Parma Sandstone
5	Bayport/Michigan Formation
6	Marshall Sandstone
7	Coldwater Shale



Layer thicknesses are averages at north end of model.

CLIENT
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PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	11/12/2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

TITLE
SIMULATED HYDROSTRATIGRAPHY

PROJECT NO.	CONTROL	REV.	FIGURE
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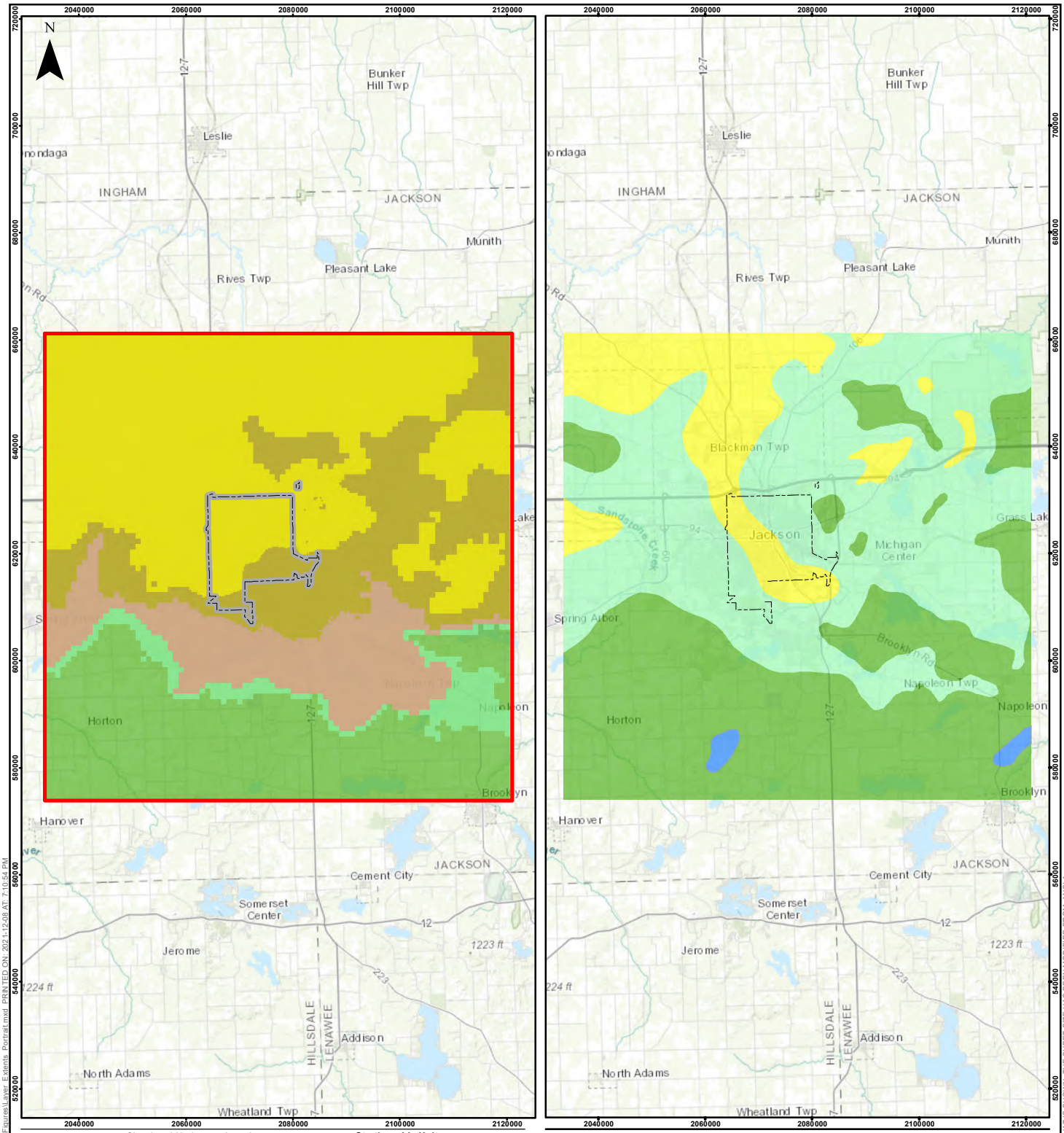

Simulated Hydrostratigraphy

- City of Jackson
- Model Domain
- Layer 2 Saginaw Aquifer
- Layer 3 Saginaw Confining Unit
- Layer 4 Parma Sandstone
- Layer 5 Bayport-Michigan
- Layer 6 Marshall Sandstone

Stratigraphic Unit

- Saginaw Formation
- Michigan Formation
- Bayport Limestone
- Marshall Formation
- Coldwater Shale

0 15,000 30,000

Feet

NOTE(S)

1. OVERBURDEN NOT SHOWN.
2. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
3. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)

REFERENCE(S)

1. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
2. STRATIGRAPHIC UNITS: EGLE (2021). DIGITIZED POLYGONS FROM 1987 MICHIGAN BEDROCK GEOLOGY MAP, MICHIGAN GEOLOGICAL SURVEY.

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CONSUMERS ENERGY COMPANY

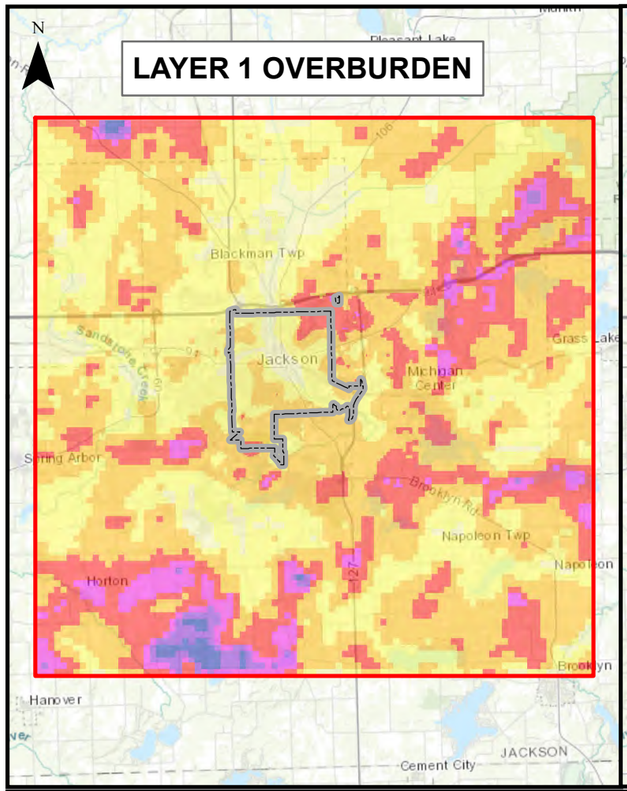
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL APPLICATION PERMIT

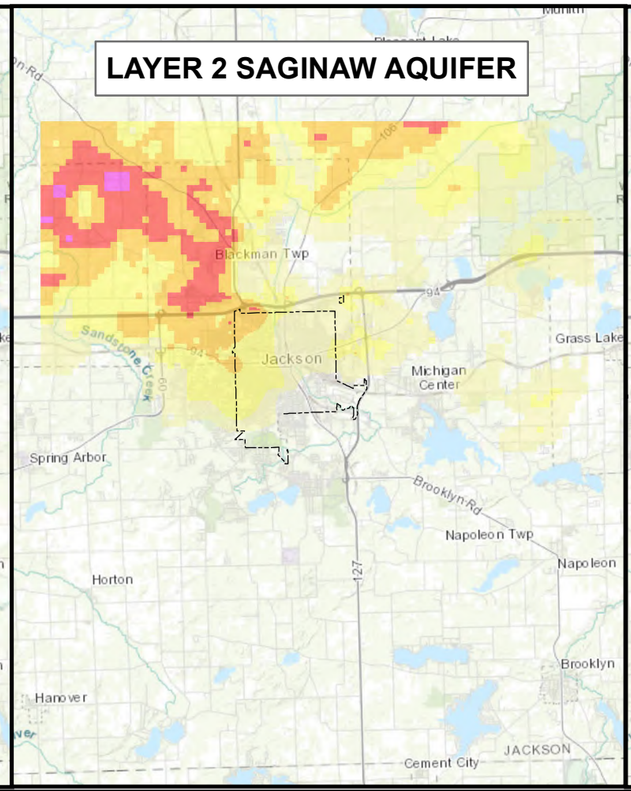
TITLE
SIMULATED HYDROSTRAGRAPHY AND STRATIGRAPHIC UNITS

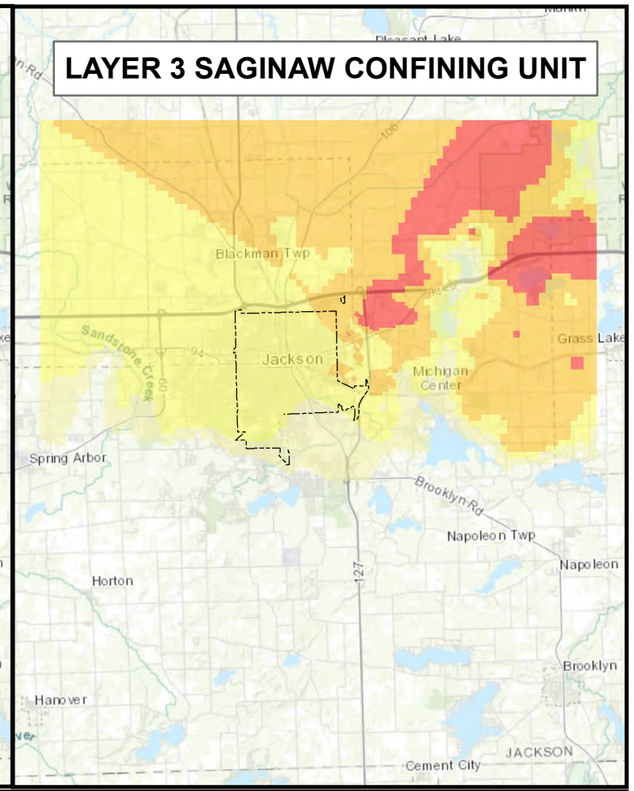
CONSULTANT

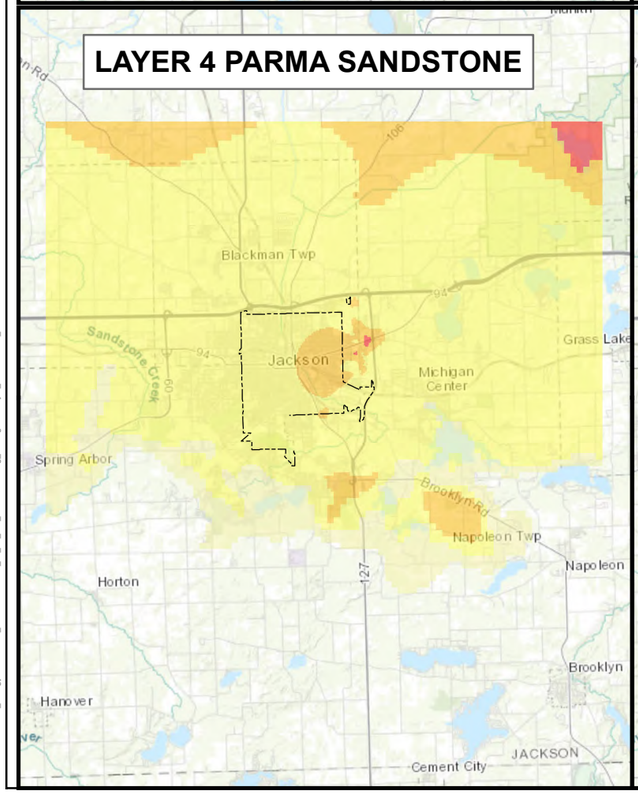
YYYY-MM-DD	11-11-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

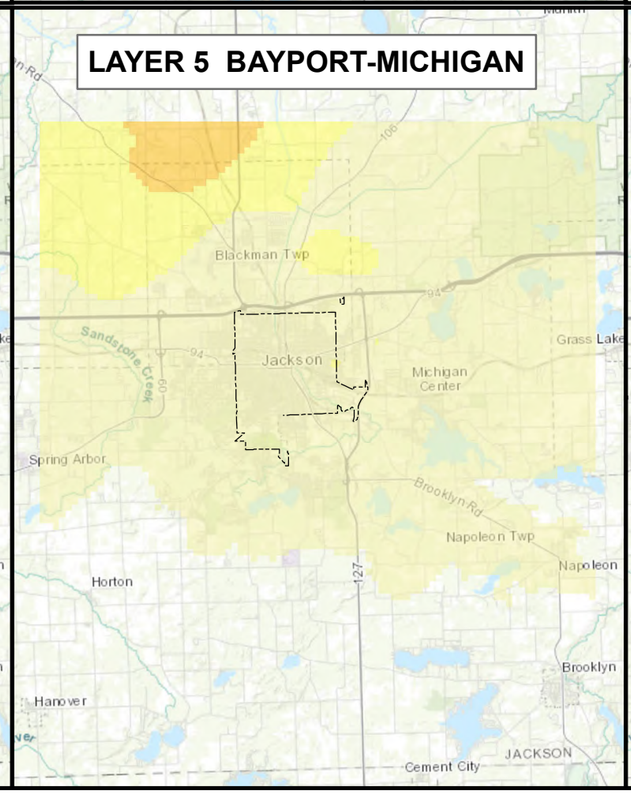
PROJECT NO. 19131361 | REV. 0 | FIGURE B-8

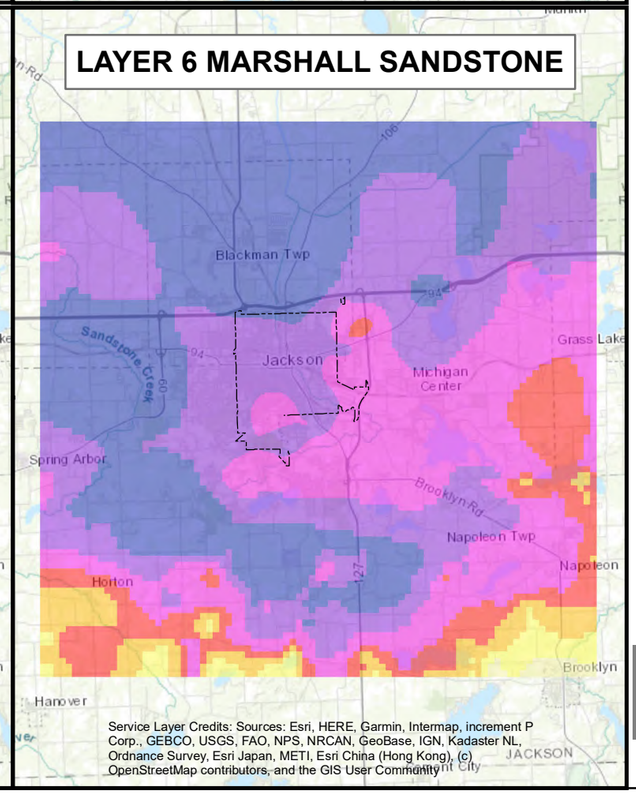












Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

LEGEND

City of Jackson

Model Domain

Layers 1 - 5 Thickness (ft)	Layer 6 Thickness (ft)
< 25	< 125
25 - 50	125 - 150
50 - 75	150 - 175
75 - 100	175 - 200
100 - 125	200 - 225
125 - 150	225 - 250
> 150	> 250

0 5 10

NOTE(S)

1. THICKNESSES DERIVED FROM BOREHOLE LOGS GATHERED FROM THE MICHIGAN EGLE WELLOGIC DATABASE.
3. LAYER 7 (COLDWATER SHALE) NOT SHOWN -- THICKNESS IS A UNIFORM 50 FEET.
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF

REFERENCE(S)

1. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
2. TOP SURFACE USED IN CALCUATION OF LAYER 1 THICKNESS PARTIALLY CALCULATED FROM USGS 3DEP DIGITAL ELEVATION MODEL (2020).

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
MODEL LAYER THICKNESSES
LAYERS 1 - 6

CONSULTANT [redacted]

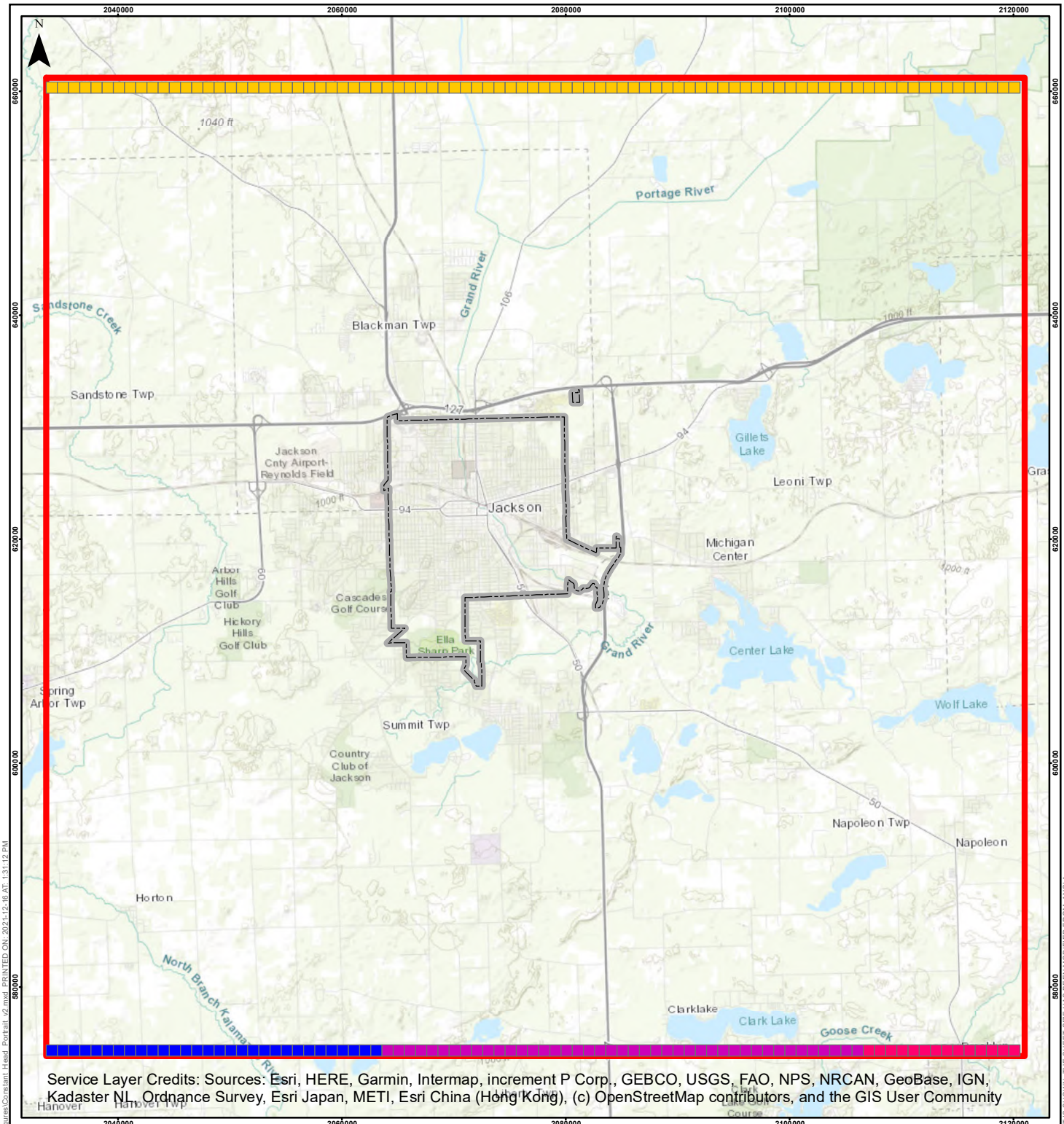
YYYY-MM-DD	11-12-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361 | REV. 0 | FIGURE B-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

1 in

PATH: G:\Consumers_Energy\Jackson\11_GIS\TEMP\2020_12_07_GK_GeoProcessing_WIF\figures\Layer_Thicknesses_25ft.mxd PRINTED ON: 2021-12-08 AT: 6:19:47 PM



Model Domain

City of Jackson

0 5,000 10,000

Feet

Contant Head Boundary Value (ft NAVD88)

- 800
- 800 - 850
- 850 - 900
- 900 - 950
- 950 - 1000
- > 1000

NOTE(S)

1. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
2. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

REFERENCE(S)

1. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
CONSTANT HEAD BOUNDARY CONDITIONS

CONSULTANT

YYYY-MM-DD	10-25-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO.	REV.	FIGURE
19131361	0	B-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0

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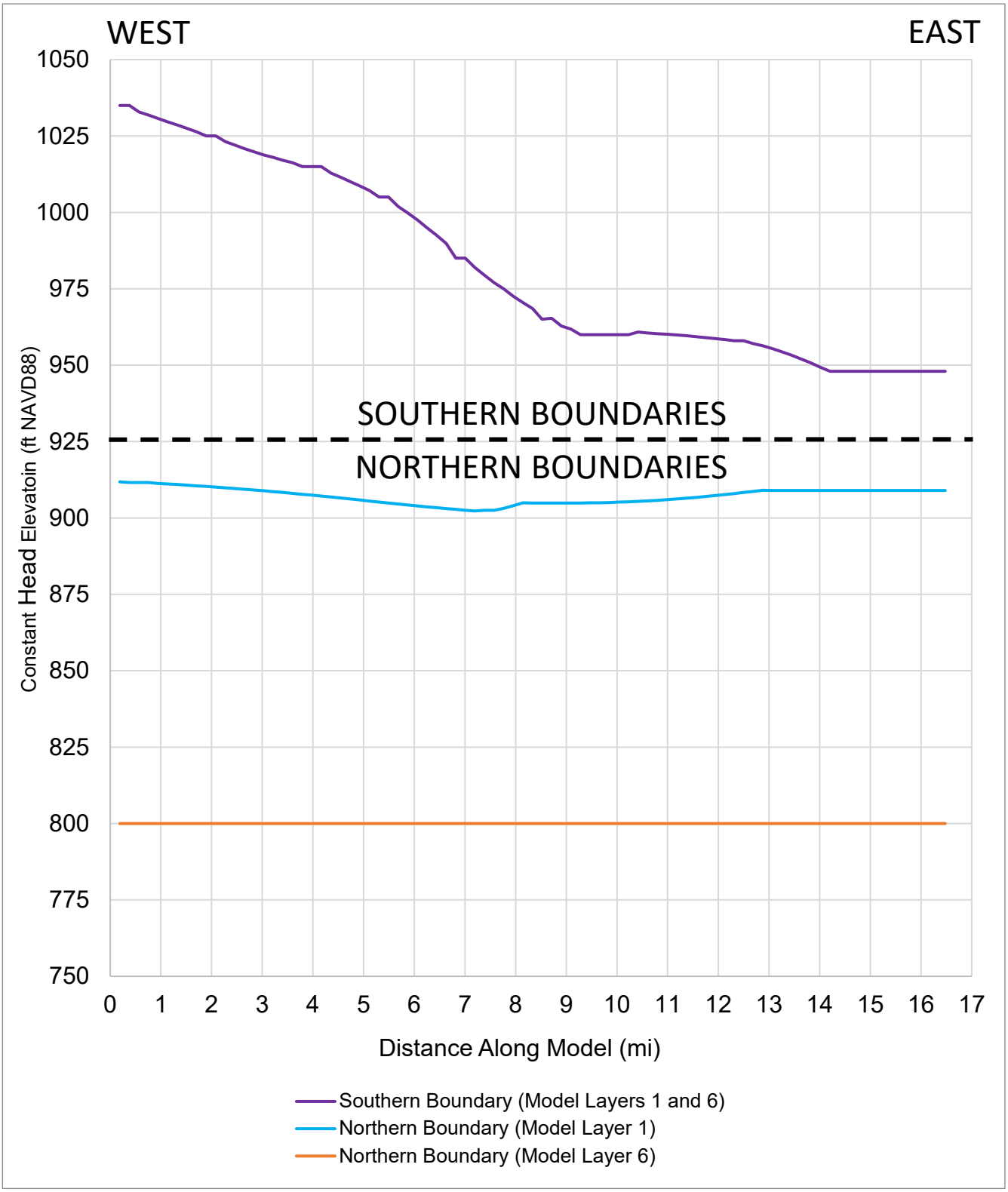


CLIENT
CONSUMERS ENERGY COMPANY

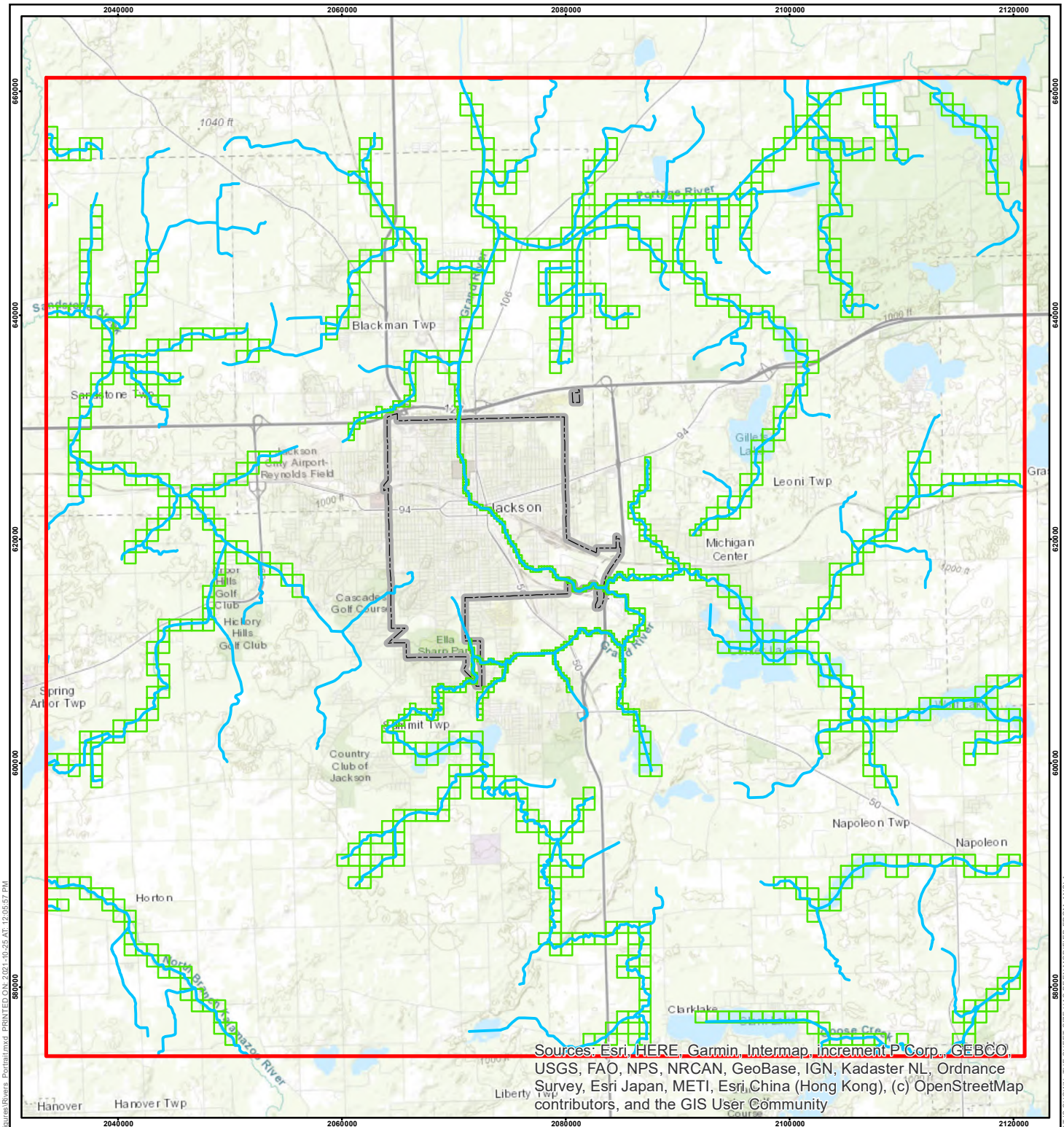
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	11/16/2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

Title
SIMULATED NORTHERN AND SOUTHERN BOUNDARY CONDITIONS

PROJECT NO.	REV.	FIGURE
19131361	0	B-11



Model Domain
EGLE Base Flow Rivers Shapefile
Modeled River Boundary Conditions
City of Jackson

0 6,250 12,500
Feet

N

NOTE(S)
1. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

REFERENCE(S)
1. BASEFLOW OF MICHIGAN STREAMS SHAPFILE: EGLE (2017)
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
CONSUMERS ENERGY COMPANY
JACKSON GENERATING STATION WATER STUDY

TITLE
RIVER BOUNDARY CONDITIONS

CONSULTANT

YYYY-MM-DD	10-25-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	####

PROJECT NO. 19131361
REV. 0
FIGURE B-12

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

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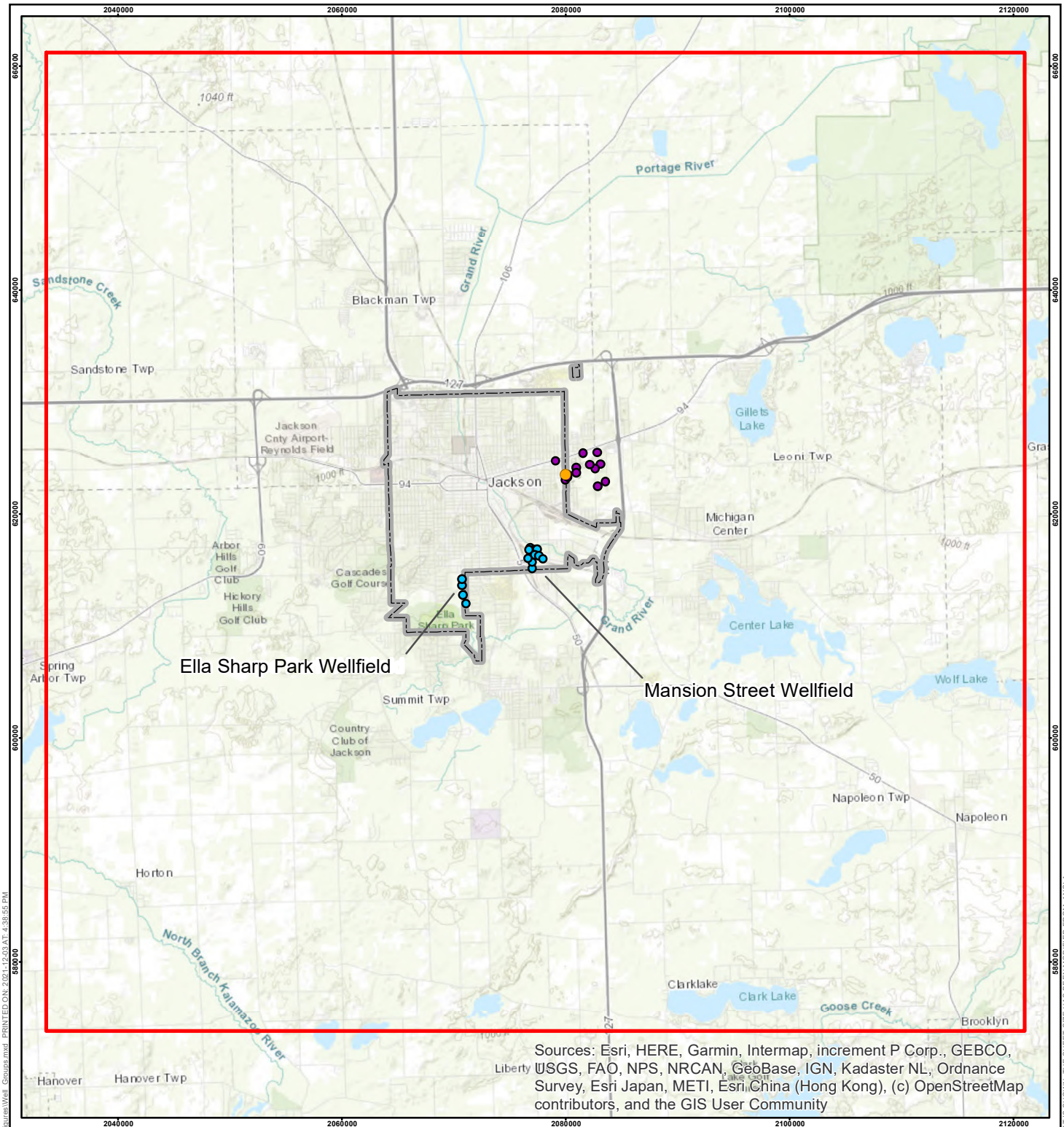


- JGS Supply Well
- Observation Wells
- City of Jackson Wells
- City of Jackson
- Model Domain

0 6,250 12,500
Feet

N

NOTE(S)

1. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT
CONSUMERS ENERGY COMPANY

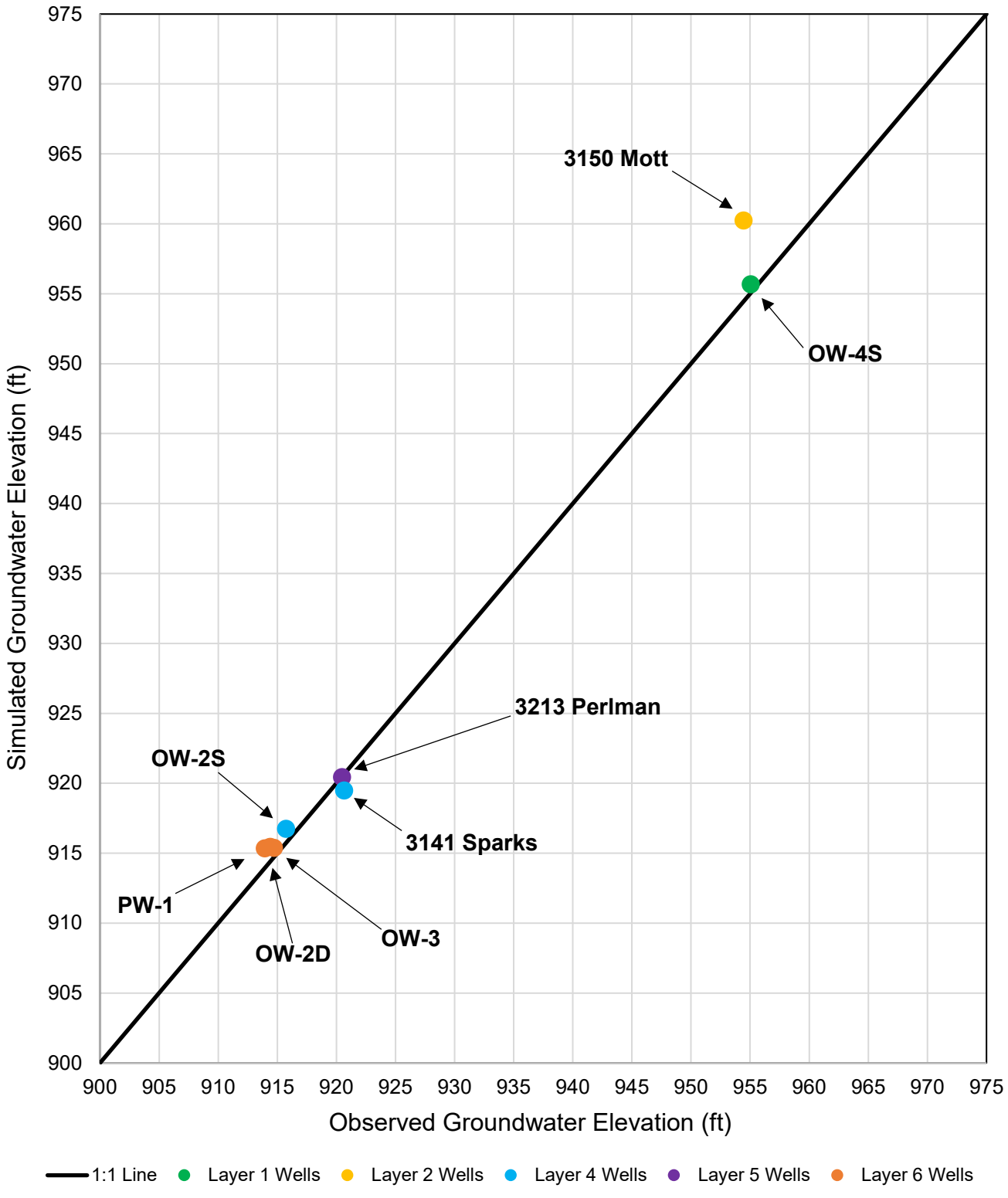
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SIMULATED WELL GROUPS

CONSULTANT

YYYY-MM-DD	12-02-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361
REV. 0
FIGURE B-13



CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	11/30/2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

TITLE
MODEL CALIBRATION
OBSERVED VS SIMULATED TARGET VALUES

PROJECT NO.	CONTROL	REV.	FIGURE
19131361		0	B-14

PATH: https://golderassociates.sharepoint.com/sites/124800/Project Files/5 Technical Work/Modelling/Documentation/Figures/Data | FILE NAME: Obs_vs_Sim.xlsx

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25 mm
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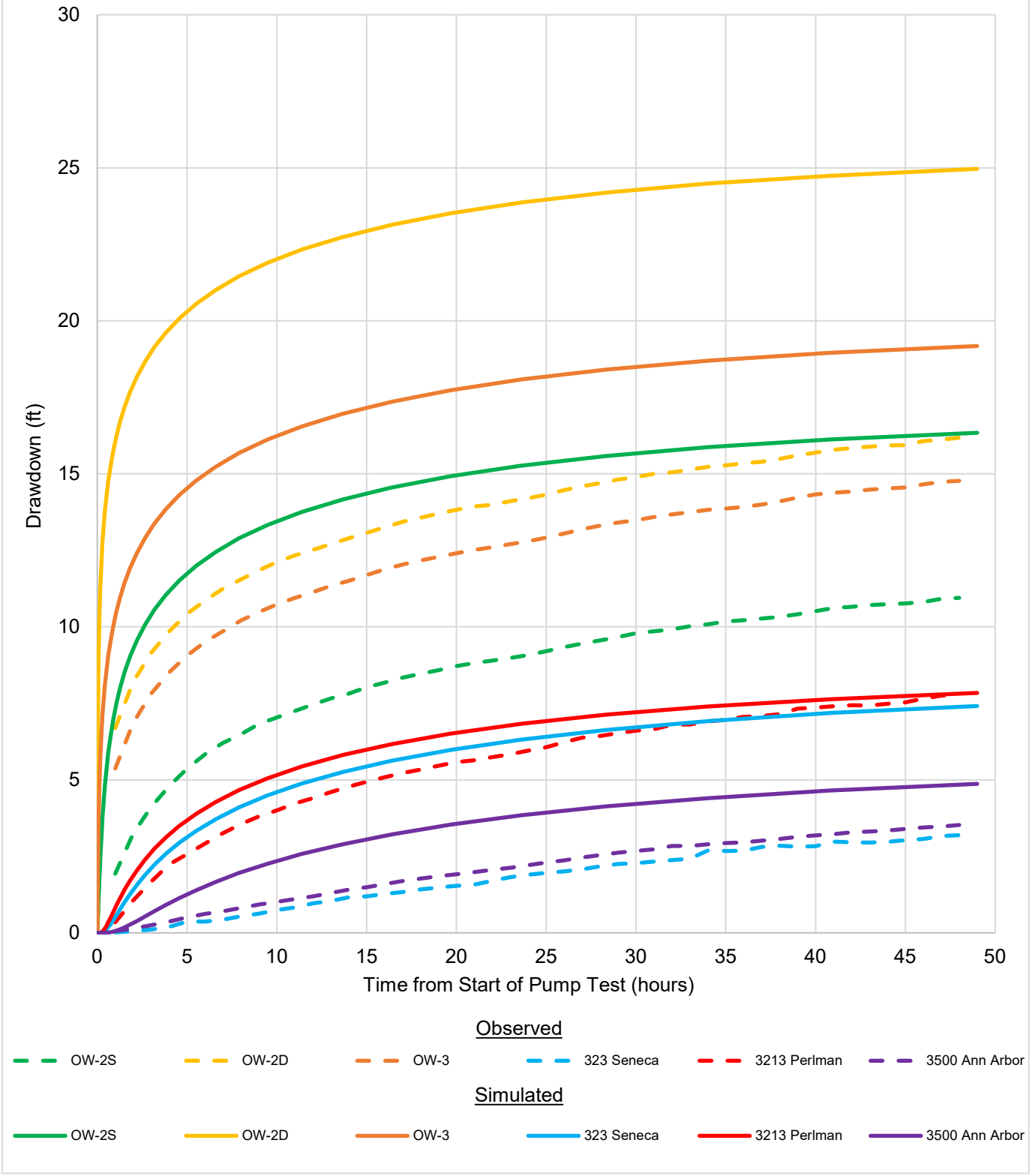


CLIENT
CONSUMERS ENERGY COMPANY

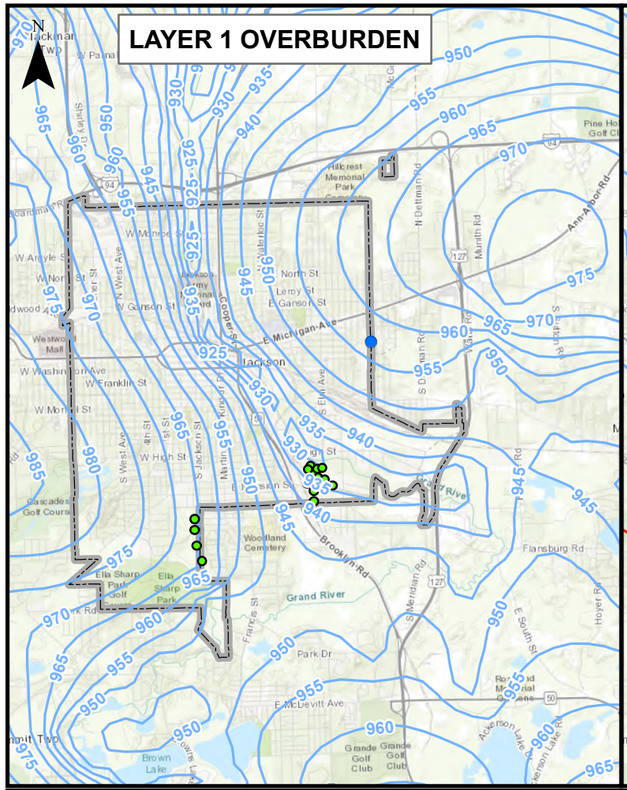
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

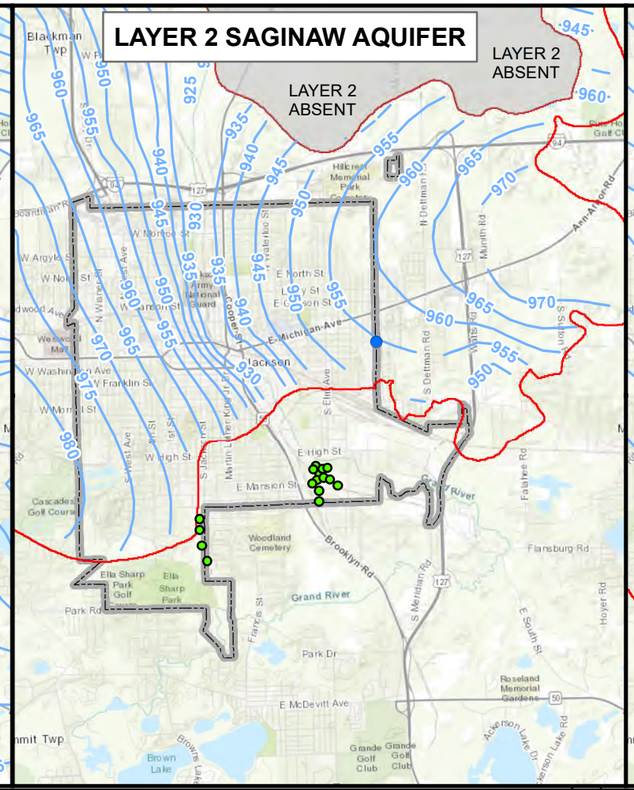
CONSULTANT
GOLDER
MEMBER OF WSP

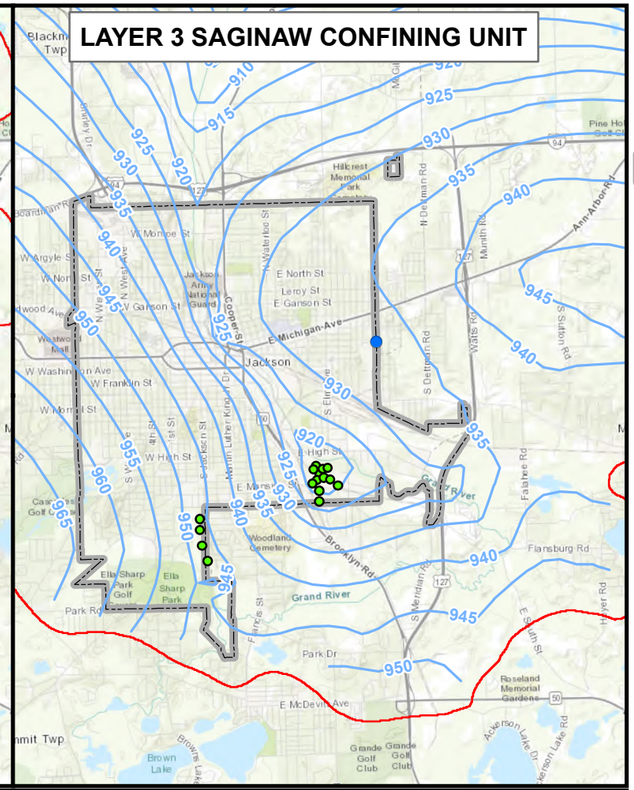
YYYY-MM-DD	11/16/2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

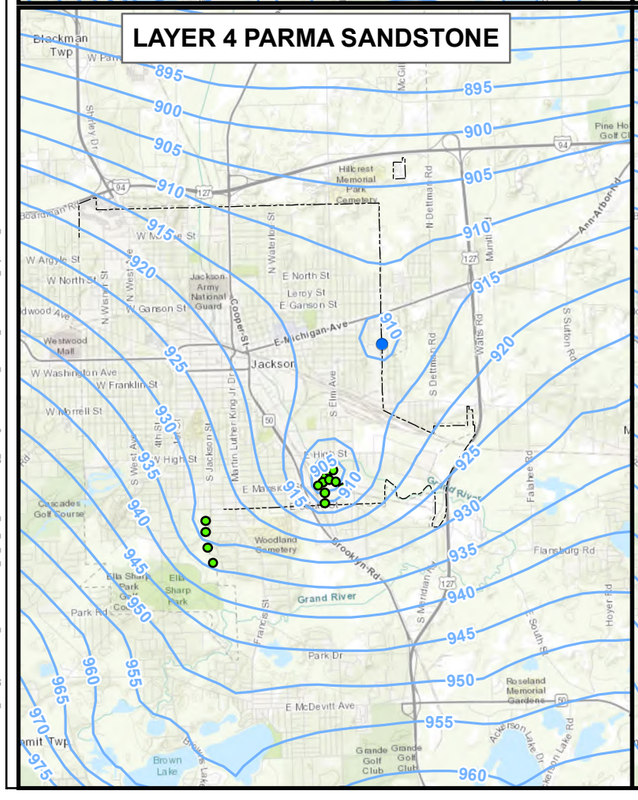
Title
PW-1 PUMPNG TEST
OBSERVED VS SIMULATED DRAWDOWN IN SELECT OBSERVATION WELLS

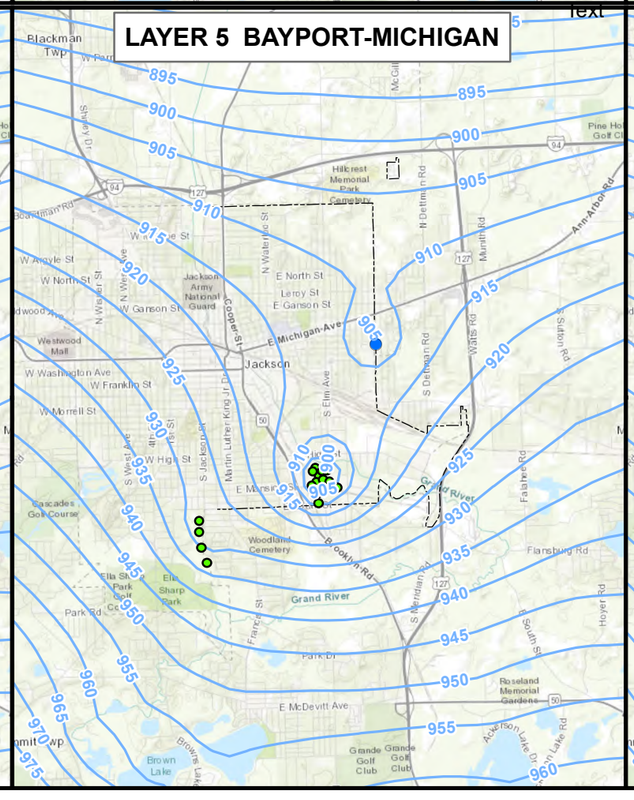
PROJECT NO.	REV.	FIGURE
19131361	0	B-15

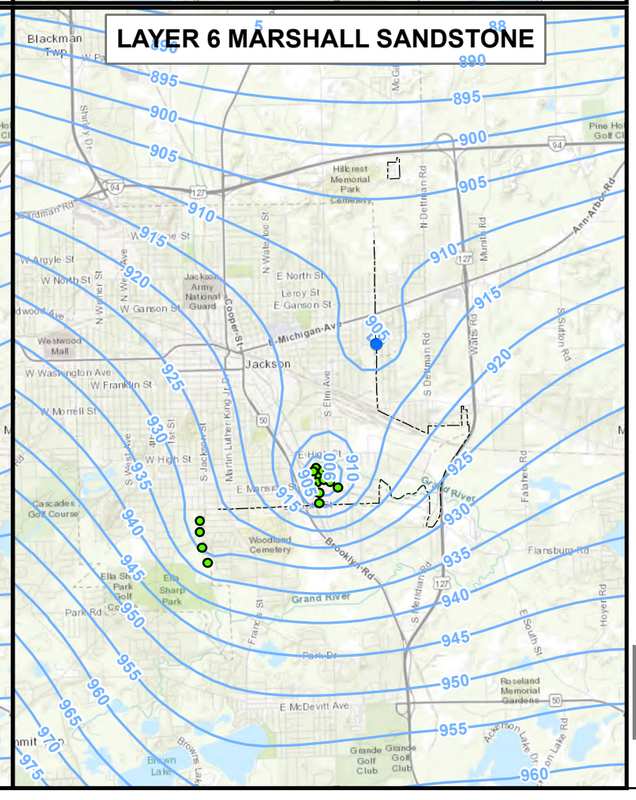












LEGEND

- City of Jackson Wells
- JGS Supply Well
- Simulated Groundwater Elevation (ft NAVD88)
- City of Jackson
- Layer Extent
  Shown for layers that do not extend throughout area of interest.

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

0 2.5 5

NOTE(S)
1. CONTOUR INTERVAL = 5 FEET (FT)
2. CONSUMERS TOTAL PUMPING RATE: 1.4 MILLION GALLONS/DAY (MGD)
3. CITY OF JACKSON WELLS, TOTAL PUMPING RATE: 5.8 MGD
4. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

REFERENCE(S)
1. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
2. WELL LOCATIONS: MICHIGAN EGLE WELLOGIC DATABASE
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SIMULATED GROUNDWATER CONTOURS FOR BASELINE CONDITIONS

CONSULTANT		
[redacted]	YYYY-MM-DD	11-16-2021
	DESIGNED	GK
	PREPARED	GK
	REVIEWED	KER
	APPROVED	JH/AO

PROJECT NO.	REV.	FIGURE
19131361	0	B-16

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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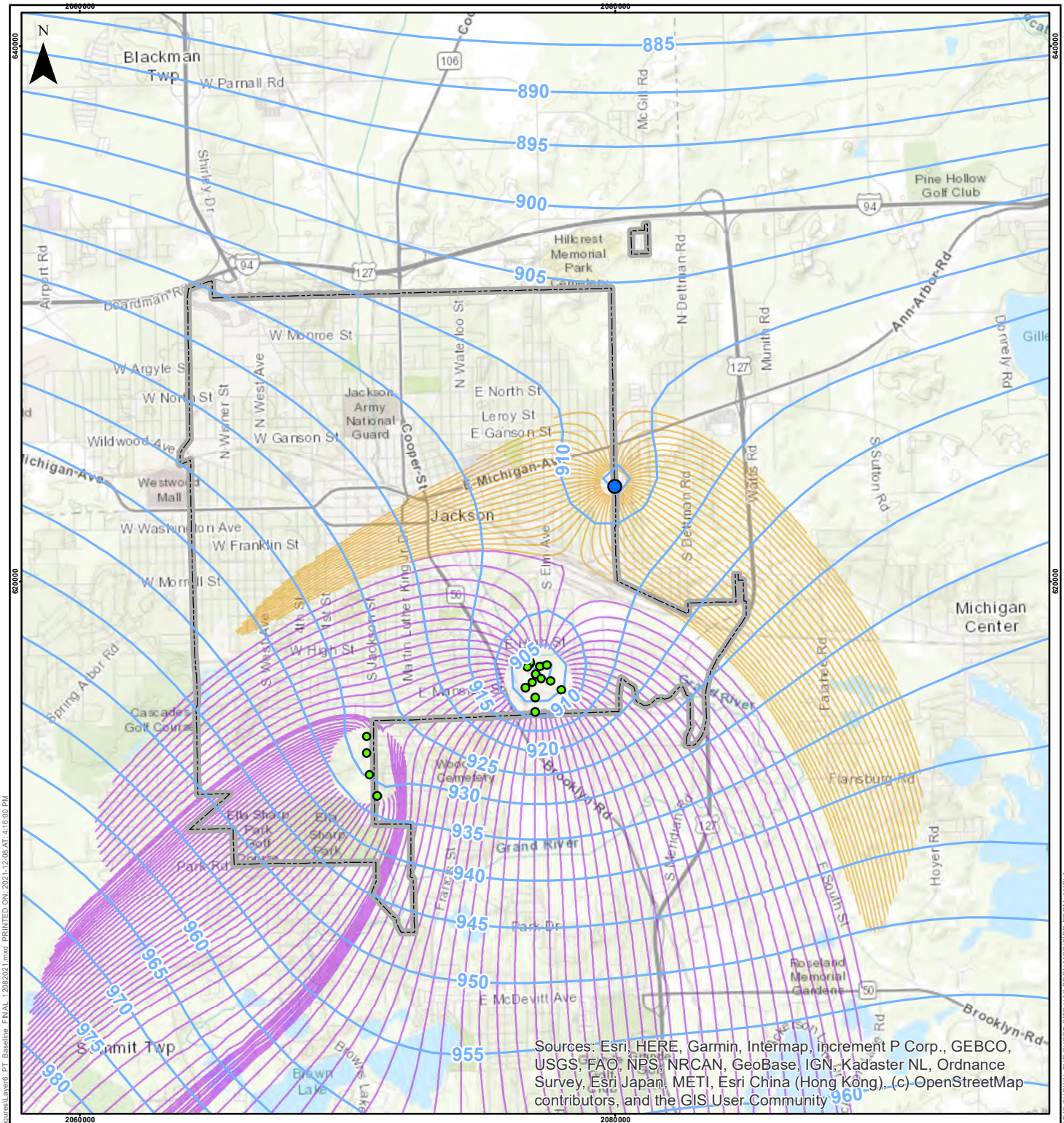

JGS Supply Well

City of Jackson Wells

Groundwater Elevation (ft NAVD88)

City of Jackson

0 5,000 10,000 Feet

Contour Interval = 5 ft

Flowpaths

JGS Supply Well

City of Jackson Wells

NOTE(S)

1. JGS PUMPING RATE = 1.4 MGD; CITY OF JACKSON PUMPING RATE = 5.8 MGD
1. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
2. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SIMULATED CAPTURE ZONES FOR BASELINE CONDITIONS IN THE MARSHALL SANDSTONE

CONSULTANT

YYYY-MM-DD	11-16-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361 | REV. 0 | FIGURE B-17

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

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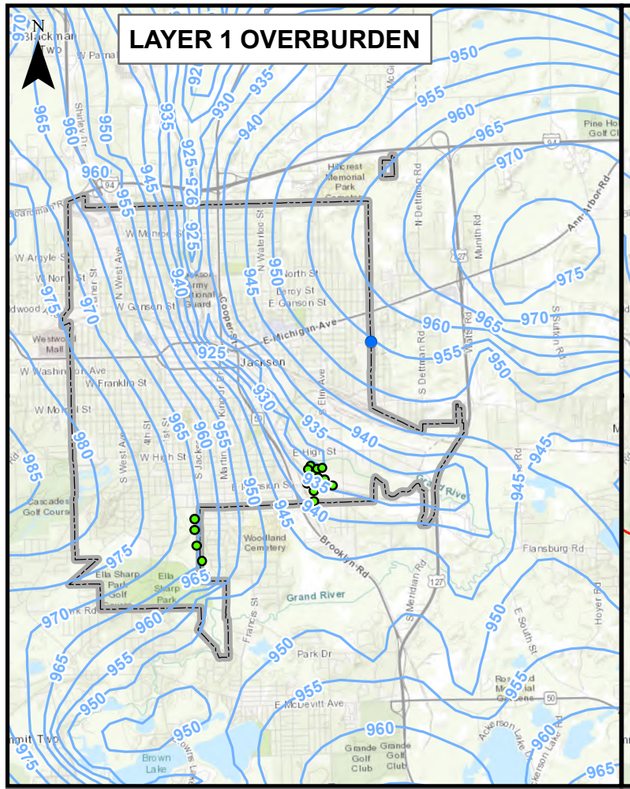
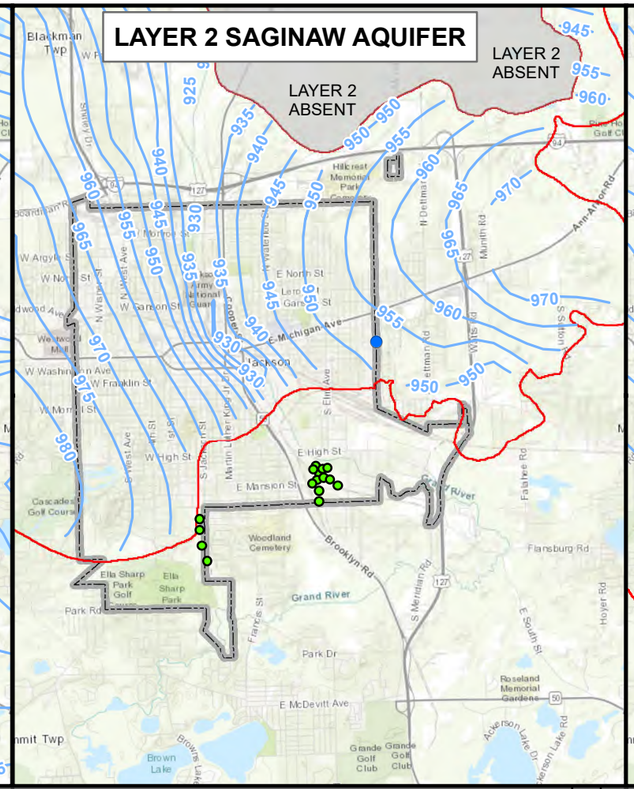
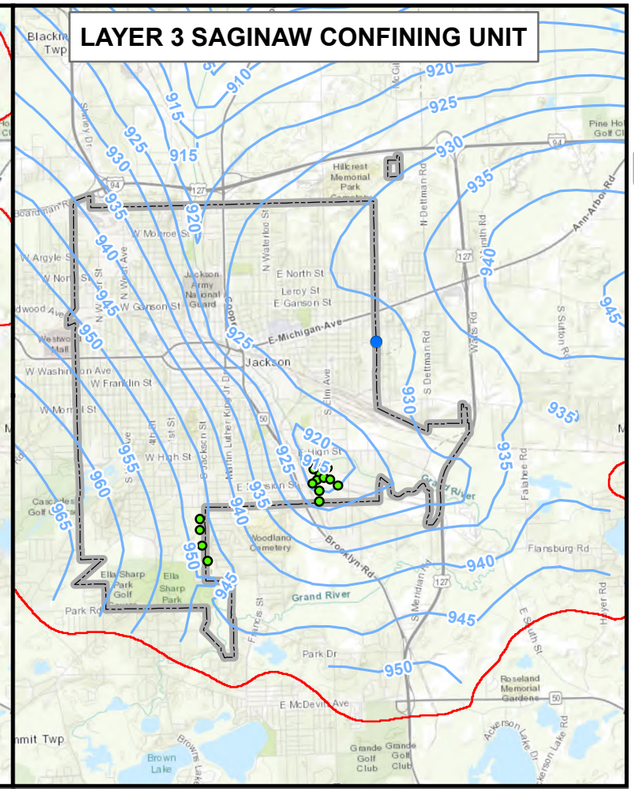
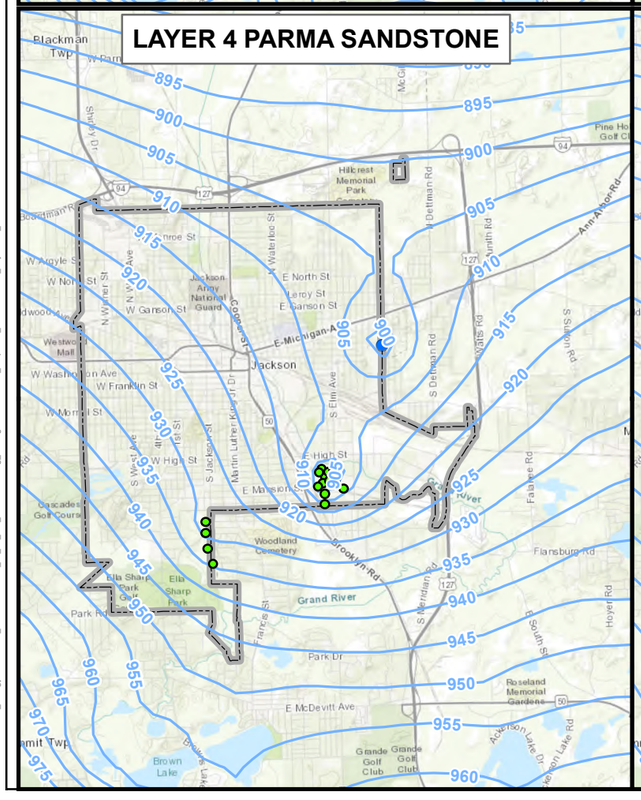
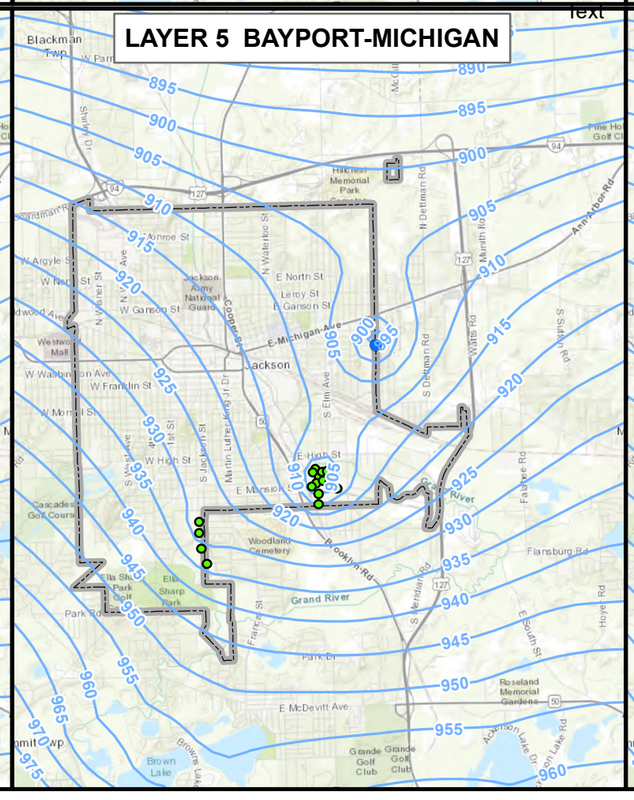
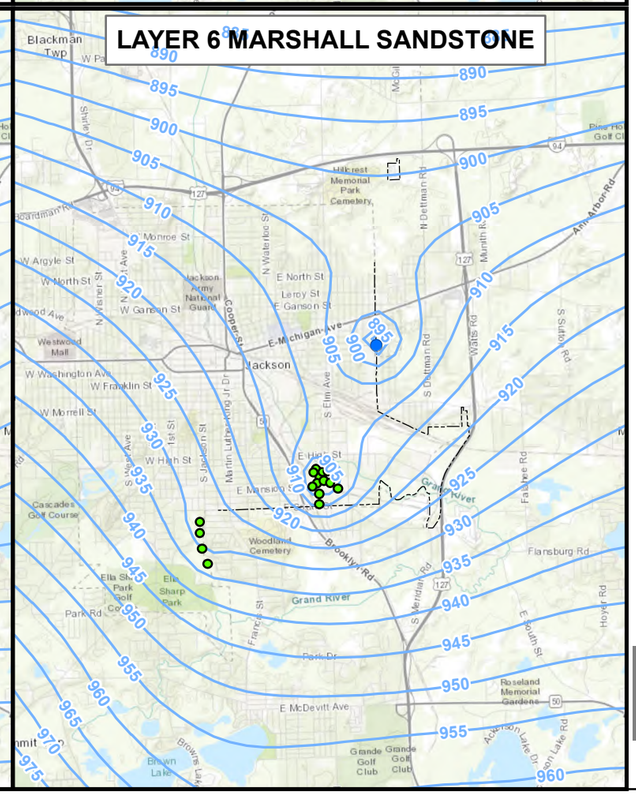












- City of Jackson Wells
- JGS Supply Well
- Simulated Groundwater Elevation
- City of Jackson
- Layer Extent
  Shown for layers that do not extend throughout area of interest.

0 2.5 5

NOTE(S)
1. CONTOUR INTERVAL = 5 FEET (FT)
2. CONSUMERS TOTAL PUMPING RATE: 2.76 MILLION GALLONS/DAY (MGD)
3. CITY OF JACKSON WELLS, TOTAL PUMPING RATE: 5.12 MGD
4. EGLE: MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

REFERENCE(S)
1. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
2. WELL LOCATIONS: MICHIGAN EGLE WELLOGIC DATABASE
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

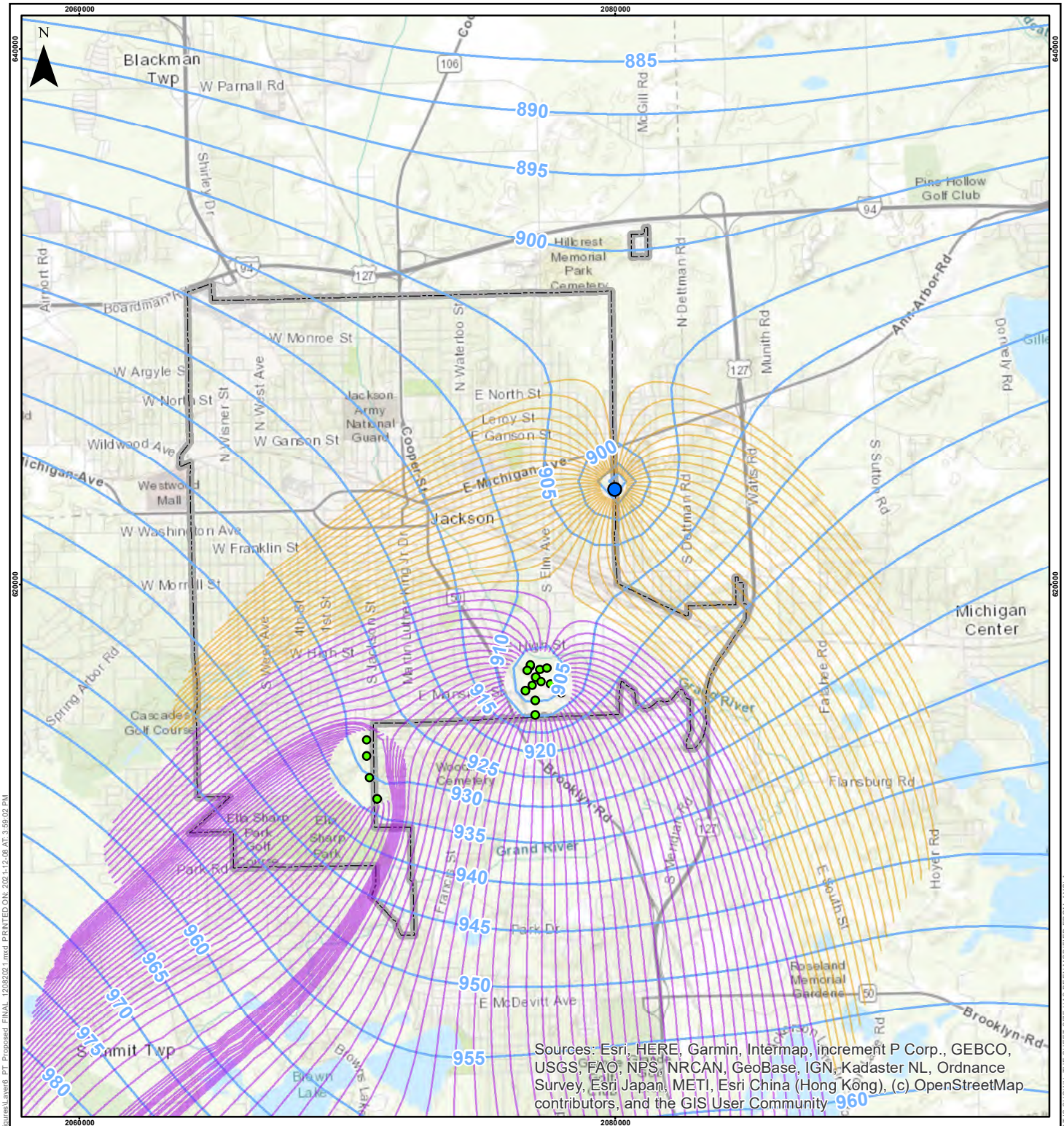
CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SIMULATED GROUNDWATER CONTOURS FOR PROPOSED PUMPING

CONSULTANT		
[redacted]	YYYY-MM-DD	11-16-2021
	DESIGNED	GK
	PREPARED	GK
	REVIEWED	KER
	APPROVED	JH/AO

PROJECT NO.	REV.	FIGURE
19131361	0	B-18



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

- JGS Supply Well
- City of Jackson Wells
- Groundwater Elevation (ft NAVD88)
- City of Jackson

0 5,000 10,000 Feet

Contour Interval = 5 ft

Flowpaths

- JGS Supply Well
- City of Jackson Wells

NOTE(S)

1. JGS PUMPING RATE = 2.76 MGD; CITY OF JACKSON PUMPING RATE = 5.12 MGD
2. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN VERTICAL DATUM OF 1983 MICHIGAN GEOREF (US FEET)
3. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD1988)

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
SIMULATED CAPTURE ZONES FOR PROPOSED PUMPING CONDITIONS IN THE MARSHALL SANDSTONE

CONSULTANT

YYYY-MM-DD	11-23-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361 | REV. 0 | FIGURE B-19

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in
0

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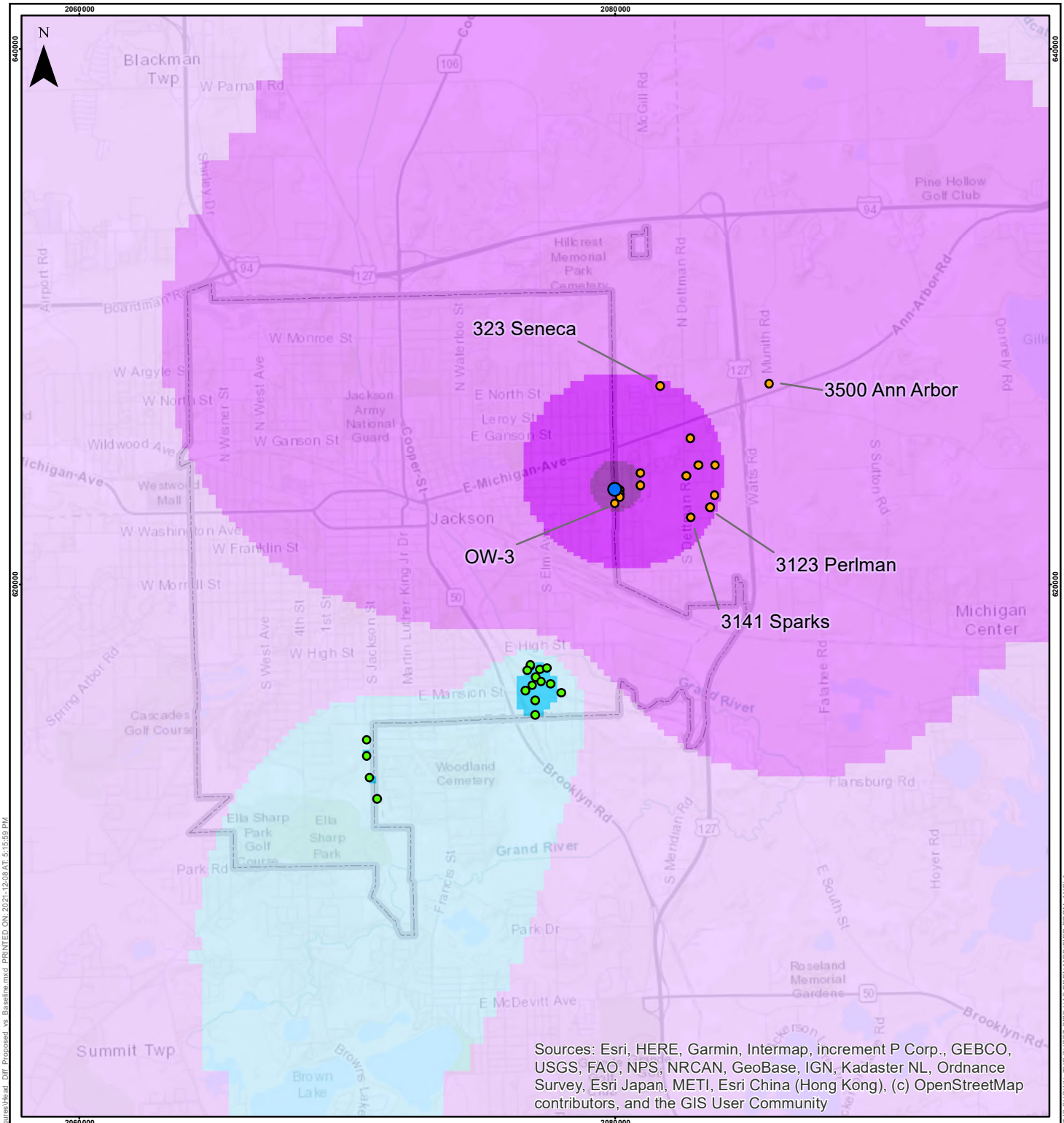

Groundwater Elevation Change

- > 1
- 0 to 1
- -1 to 0
- -5 to -1
- -10 to -5
- < -10

- JGS Supply Well
- Observation Wells
- City of Jackson Wells
- City of Jackson

0 2,500 5,000 Feet

NOTE(S)

1. DRAWDOWN CALCULATED AS (GROUNDWATER ELEVATION FOR PREDICTIVE SIMULATION] - [GROUNDWATER ELEVATION FOR BASELINE SIMULATION])
2. CITY OF JACKSON TOTAL PUMPING = 5.12 MGD
3. JGS TOTAL PUMPING = 2.76 MGD

REFERENCE(S)

1. WELL LOCATIONS FROM EGLE WELLOGIC DATABASE
2. CITY OF JACKSON BOUNDARY: MICHIGAN GIS OPEN DATA (2021)
3. HORIZONTAL COORDINATE SYSTEM: NORTH AMERICAN DATUM OF 1983 MICHIGAN GEOREF (US FEET)
4. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

TITLE
CHANGE IN GROUNDWATER ELEVATION IN THE MARSHALL SANDSTONE ATTRIBUTED TO THE INCREASED PUMPING AT THE JGS SUPPLY WELL

CONSULTANT

YYYY-MM-DD	11-23-2021
DESIGNED	GK
PREPARED	GK
REVIEWED	KER
APPROVED	JH/AO

PROJECT NO. 19131361 | REV. 0 | FIGURE B-20

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

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TECHNICAL MEMORANDUM

DATE December 20, 2021

TO Ms. Rachel Proctor, Consumer's Energy

CC

FROM Joel Henry **EMAIL** jhenry@golder.com

ATTACHMENT C: PRIVATE PROPERTY CONFLICT CONTINGENCY PLAN

In June 2020, Consumers Energy Company (CEC) constructed water supply well (PW-1) at the Jackson Generating Station (JGS) in Jackson, Michigan to provide water for electric generation and evaporative cooling that is currently being purchased from the City of Jackson municipal supply. Well PW-1 was registered to withdraw water at a maximum rate of 1,388 gallons per minute (GPM), equivalent to 2 million gallons per day (2 MGD) on March 15, 2020. Currently, CEC is applying for permit approval under Part 327 of the Natural Resources and Environmental Protection Act, 1994 PA 451, to withdraw greater than 2 MGD of groundwater, using well PW-1 plus up to two additional supply wells proposed to be constructed on properties adjacent to the JGS.

Well PW-1 is located in the northwest corner of parcel 000-08-36-409-004-00, in the SW1/4 of the SE1/4 of Section 36 in Blackman Township, Jackson County (Figure C-1). Private residences and commercial properties in the City of Jackson, most of Summit Township, and most nearby areas of Blackman Township are served with municipal water from Jackson. Commercial corridors along East Michigan Avenue and Page Avenue are also serviced with municipal water. A few residents in Blackman Township, at least one residence in Summit Township, and the majority of residents in Leoni Township rely on private wells.

To assess the effects of withdrawing water near JGS instead of from the City of Jackson wellfields, a numeric groundwater model was developed (Attachment B). The model was calibrated using July 2021 aquifer testing data, and baseline environmental monitoring of groundwater conditions at the site since May 2020. Datalogging pressure transducers were installed in 11 nearby private residential wells beginning in March 2021 to evaluate influences of both the new JGS well, and the City of Jackson municipal wells on both shallow and deep aquifers.

By withdrawing groundwater near JGS rather than the City, water levels will decline near the new JGS supply wells and rise near the City wellfields. The purpose of this memorandum is to develop the foundation for evaluating risks to private water supplies, and to present CEC's mitigation strategy to be implemented if well interference complaints are alleged. The memorandum discusses:

- A summary of the physical and hydrogeologic characteristics of the geologic units in which local wells are constructed, and the anticipated effects;
- A summary of nearby residential wells from online and scanned Water Well Records;
- An estimation of the number and location of wells that may be "at risk";
- The proposed mitigation plan.

The overall number of private wells that ultimately may be affected by the withdrawal is expected to be small and may be zero. However, EGLE Water Well Records could be obtained for only about one-third of the nearby residences expected to have private wells. Therefore, this memorandum extrapolates from this subset of well records to best estimate of where well conflicts could potentially occur.

SITE GEOLOGY AND HYDROGEOLOGY

As discussed in Section 4 of the Permit Application (Evaluation of Existing Hydrologic and Hydrogeologic Conditions), there are three water-bearing aquifers at the site: the Saginaw aquifer, the Parma/Bayport (P/B) aquifer, and the Marshall aquifer. There is not a glacial aquifer at the site, although in nearby areas such as north of East Michigan Avenue, and west of North Dettman, a saturated sand unit exists at the bottom of the glacial overburden which meets residential water needs. There are two aquitards that resist the vertical movement of water between bedrock aquifers: the Saginaw confining unit, located between the Saginaw aquifer and the Parma/Bayport (P/B) aquifer; and the Michigan formation, located between the P/B aquifer and the Marshall aquifer. A regional aquiclude, the Coldwater shale, underlies the Marshall aquifer and defines the base of regional freshwater resources.

Evidence from long-term monitoring and aquifer testing suggests that the Michigan formation aquitard is thin or not present near the JGS site, such that withdrawals from the Marshall aquifer by the City of Jackson or the new JGS supply well result in water level drawdown in the overlying P/B aquifer (Section 4.3.3). The Saginaw confining unit appears to be laterally continuous and confining near JGS. Wells open to formations above the confining unit typically have water levels between 950 and 960 ft amsl, and wells only open below the confining unit typically have water levels between 920 and 930 ft amsl.

The degree to which a private well experiences impact from regional water withdrawals depends on its casing depth. Local bedrock wells are constructed by cementing a steel casing a few feet into the uppermost competent bedrock (typically the Saginaw formation), at depths typically between 50 to 80 feet below grade. The borehole is then extended beyond the end of the steel casing, drilling through one or more bedrock units until sufficient water yield is obtained.

- Wells completed above the Saginaw confining unit (i.e., Saginaw aquifer or overburden, and generally less than 120 feet deep) have water levels approximately 950 to 960 ft amsl and are unaffected by withdrawals from the deep bedrock aquifer. Examples from the Permit Application include private wells at 2602 Chapin, 334 Watts, 226 Briscoe, 3150 Mott, and 357 Sheridan (Figure C-2).
- Wells completed in the P/B aquifer, but are cased above the Saginaw confining unit, also have water levels that reflect the potentiometric head of the Saginaw aquifer (i.e., around 950 to 960 ft amsl). Examples from the Permit Application include private wells at 429 Dettman and 539 Sheridan (Figures C-2 and C-3).
- Wells completed in the P/B aquifer, but are cased into or through the Saginaw confining unit, have water levels that reflect the potentiometric head of the P/B aquifer (i.e., around 920 to 930 ft amsl). Examples from the Permit Application include private wells at 3141 Sparks and 3213 Perlman (Figure C-3).
- No residential wells, and only a few commercial wells are completed in the Marshall sandstone aquifer (more than 200 feet below grade), where water levels are approximately 920 to 930 ft amsl. However, even the commercial well at 3500 Ann Arbor (Maurer's Car Wash) is only cased to 73 feet below grade and may receive water from the overlying Saginaw and Parma sandstones (Figure C-4).

As discussed in Section 4.2.2 (Regional Bedrock Geology), bedrock dips to the north, with the Saginaw aquifer being the surficial bedrock unit at JGS well PW-1. The Saginaw aquifer is not present at well OW-3, 500 feet

south of PW-1, and is noted in few Water Well Records to the south and east of JGS. Private wells in the neighborhoods to the east and southeast of JGS are therefore generally cased into the Saginaw confining unit.

At private wells east and northeast of JGS, the Saginaw aquifer is generally present, and most wells are cased into the Saginaw aquifer sandstone. Wells cased into the upper portion of the Saginaw aquifer, but still remain open to most of the Saginaw aquifer, will have a water level consistent with the Saginaw (950 to 960 ft amsl) regardless of whether the bottom of the well extends into the Parma sandstone or deeper. With the opportunity to draw water from multiple formations, these wells are less sensitive to high-capacity withdrawals than wells cased into the Saginaw confining unit, and open only below the confining unit (i.e., compare 539 Sheridan with 3213 Perlman, which have the identical depths (180 feet) and are located approximately 500 feet apart (Figures C-2 and C-3).

RESIDENTIAL WELL EVALUATION

Two sources of water well records were reviewed – the Wellogic database, and the State of Michigan scanned water well records. Generally, the Wellogic records represent more recently-installed wells, and the scanned well records represent wells drilled between the 1960's and 1990's. Some water well records may represent residences and businesses, particularly in Summit Township, which have since been connected to the City of Jackson municipal supply and have likely been abandoned.

Reviewing six "neighborhoods" near the JGS (Figure C-5), approximately one-third of properties (133 of 360 properties) could be paired with an EGLE water well record. Because of the partial completeness of this dataset, not all risks to all residential wells can be known, so the following analysis was prepared to inform and illustrate potential risks and their geographic distribution. Five of these six neighborhoods rely primarily on private wells for water supply, the exception being Neighborhood "C" in Summit Township, where only one residence is known to remain on a private well.

Neighborhood "A"

Neighborhood "A" is the nearest cluster of homes to JGS, consisting of approximately 24 residential properties in the SE1/4 of Section 36 of Blackman Township and approximately 800 to 2,000 feet east to northeast of well PW-1 (Figure C-5). The neighborhood is located south of Tyson Street, and along Henrietta, Watts, and Amos Streets. Also included are the Heritage and Arbor apartments between Amos Street and S. Dettman Road, which have three known wells used for landscape irrigation.

At least four residences in the southern portion of Neighborhood "A" rely on private wells. The four known wells are cased into and pump water from the Saginaw aquifer. Well depths range from 75 to 122 feet, and the average static water level these wells is 17 feet, or about 950-960 ft amsl. Residential wells at 334 Watts and 2602 Chapin were instrumented in March 2021. Static water levels in these two wells ranged from 954 to 954.5 feet amsl and decline less than 3 feet when the residence's submersible pumps activate (Figure C-2). After five months of monitoring, there is no evidence that these Saginaw aquifer wells are affected by either the JGS well or City of Jackson withdrawals.

The landscape irrigation wells at the Heritage and Arbor Apartments are completed deep in the Parma and Marshall aquifers, with depths of 180, 210, and 290 feet below grade, but cased only to 50, 57, and 46 feet below grade respectively, which corresponds to the top of the Saginaw aquifer. Even though the irrigation wells are less than 2,000 feet from JGS supply well PW-1, no interference is expected because any drawdown induced at these wells will likely be compensated by an influx of water from the Saginaw aquifer. The owners of the apartments were contacted about instrumenting any of three irrigation wells, but access could not be obtained.

Neighborhood "B"

Neighborhood "B" consists of approximately 100 residential properties in the SW1/4 of Section 31 of Leoni Township, approximately 2,600 to 4,000 feet east to northeast of the supply well (Figure C-5). The neighborhood consists of Leoni Township properties east of S. Dettman Road, west of US-127, and north of Perlman Street. A total of 38 well records were located, approximately one-third of the 100 residences. Of these 38 well records, two wells are screened in the overburden, 24 wells are completed in the Saginaw aquifer, and 12 wells are completed in the P/B aquifer. None are interpreted as being completed in the Marshall sandstone.

- The two overburden wells average 37 feet deep, with a static water level of 13 feet.
- The 24 Saginaw aquifer wells range from 47 to 102 feet deep, with an average depth of 79 feet, and an average static water level of 24 feet.
- The wells interpreted to be in the P/B aquifer range in depth from 120 to 210 feet, with an average depth of 165 feet. Subdividing these 12 wells based on their casing depth;
  - Six P/B wells are cased to the top of the Saginaw aquifer, and appear to pump water from the Saginaw aquifer, and have an average static water level of 18 feet below grade.
  - Six P/B wells are cased into the Saginaw confining unit, sealing off the Saginaw aquifer and drawing water from the Parma sandstone, and have an average static water level of 38 feet below grade.

Five wells in Neighborhood "B" have been instrumented with dataloggers: 3150 Mott (Saginaw Aq., 76 feet deep), 357 Sheridan (Saginaw Aq., 80 feet deep), 226 Briscoe (Saginaw Aq., 102 feet deep), 539 Sheridan (Parma Aq., 180 feet deep), and 429 S Dettman (Parma Aq., 181 feet deep). The three Saginaw Aquifer wells do not respond to water withdrawals by the City of Jackson, or the new JGS well. The static water level in these wells is 954 to 954.5 feet amsl (Figure C-2).

The Parma aquifer well at 539 Sheridan is cased only to 65 feet below grade (Saginaw Aquifer), has a static water level approximately 952 ft amsl, and does not respond to the JGS withdrawal (Figure 20). The Parma well at 429 S. Dettman has a static water level around 948 to 951 ft amsl and is slightly sensitive to regional high-capacity withdrawals (Figure C-3).

Extrapolating from the water well records, approximately 30 wells in Neighborhood "B" are inferred to be drilled to the Parma formation; and of those, approximately one-half (15) are cased only to the Saginaw aquifer, and reflect the potentiometric head of the Saginaw; and the other one-half (15) are cased into or through the Saginaw confining unit. These latter 15 wells could be considered sensitive to nearby high-capacity withdrawals.

Modelling indicates that at an additional steady-state withdrawal of 1.36 MGD, an additional 10 to 15 feet of drawdown could potentially be observed in Neighborhood "B". Extrapolating from the 6 of 38 wells identified as potentially sensitive to high-capacity withdrawals, to the approximately 100 wells in the neighborhood, there may be 15 to 20 wells at risk of experiencing interference.

Neighborhood "C"

Neighborhood "C" consists of residences north of Page Avenue and west of S. Dettman Road in the NE1/4 of Section 1 of Summit Township (Figure C-5). The neighborhood is approximately 900 to 3,300 feet southeast of the supply well. According to the Summit Township Master Plan, water is supplied to this portion of Summit Township by the City of Jackson, and private wells were abandoned once municipal supply became available.

Although 10 water well records were located, only one was drilled within the last 30 years, in 2001. It is believed that most if not all private wells in this neighborhood have been abandoned.

The 2001 well is located at 850 S. Dettman, about 2,300 feet southeast of well PW-1. Due to the 1,000-foot distance from the residence to the water main along S. Dettman, it appears that the residence retained use of its private well. The well is 207 feet deep and may be completed near the top of the Marshall sandstone. The casing depth is 100 feet, which appears to be within the Saginaw confining unit, so it is inferred that the well will be sensitive to high-capacity withdrawals. Permission to instrument the well was requested from the owner but was not granted.

Modelling indicates that at an additional steady-state withdrawal of 1.36 MGD, approximately 15 feet of drawdown could be observed at this well. The well's submersible pump is set at 75 feet below grade, or about 20 feet below the static water level. If necessary, the proposed mitigation for this well would be to lower the pump by 20 feet; approximately 130 feet remain between the pump and bottom of the well.

Neighborhood "D"

Neighborhood "D" consists of approximately 40 residences in the NW1/4 of Section 6 of Leoni Township, approximately 2,600 to 4,000 feet east to southeast of the JGS supply well (Figure C-5). The neighborhood is defined as properties along and east of S. Dettman Road, along and south of Perlman Road, and west of US-127. Overall, 18 well records for the 40 properties were located (45%).

Of the 18 well records, one well is completed in the Saginaw aquifer, and 17 are completed in the P/B aquifer. Of the 17 P/B wells, four appear to be cased into the Saginaw aquifer, and water levels in these wells average 23 feet below grade. The 13 remaining P/B wells appear to be cased into the Saginaw confining unit and have an average water level of 48 feet below grade.

Overall, Neighborhood "D" has fewer wells completed above the Saginaw confining unit than Neighborhood "B" to the north, and more wells cased into and completed below the Saginaw confining unit. Therefore, the majority of the 40 wells in this neighborhood are expected to be sensitive to high-capacity withdrawals by the City of Jackson and JGS.

Two wells in Neighborhood "D" have been instrumented, at 3141 Sparks (Parma aquifer, 157 feet deep) and 3213 Perlman (Parma aquifer, 180 feet deep). Both wells are cased into the Saginaw confining unit, and both are sensitive to high-capacity groundwater withdrawals. Static water levels in these wells are approximately 924 ft amsl, but declined to approximately 914 ft amsl during 2021 in response to high-capacity withdrawals (Figure C-3).

Modeling indicates that at an additional steady-state withdrawal of 1.36 MGD, an additional 10 to 15 feet of drawdown could potentially be observed in Neighborhood "D". Extrapolating from the 17 of 40 wells identified as potentially sensitive to high-capacity withdrawals, to the approximately 100 wells in the neighborhood, there may be 30 to 35 wells at risk of experiencing interference.

Neighborhood "E"

Neighborhood "E" is an area of Blackman Township, north of East Michigan Avenue, between 3,500 and 6,300 feet northeast of the supply well (Figure C-5). According to the Blackman Township Master Plan, residences along Whitlock Road in the SE/14 of Section 25 are not supplied with municipal water. Residences in the neighborhood just south of Whitlock Road, bounded by N. Dettman, Key Street, and Chippewa Trail in the NE1/4 of Section 36, are mapped as being supplied water but an unknown number of residences have retained their private well.

There are approximately 150 residences along Whitlock Road and the neighborhood bounded by Chippewa Trail and Key Street, with 40 well records available (27%). Of these 40 records, six wells are screened in the overburden (average depth, 31 feet), six are completed in the Saginaw formation (average depth, 107 feet), and 28 wells (70% of wells) are inferred to be completed in the P/B aquifer.

- The six Saginaw formation wells have an average water level of 38 feet below grade, and an average depth of 107 feet. Ground surface elevations in the neighborhood range between 980 and 995 ft amsl.
- Eight of the 28 P/B wells appear to be cased into the Saginaw aquifer, and have similar water levels as the Saginaw aquifer wells. The average depth of these wells is 173 feet, and the average water level is 34 feet below grade.
- The remaining 20 P/B wells have an average depth of 192 feet, and an average water level of 64 feet below grade. These wells are inferred to be cased into the Saginaw confining unit, and not open to the Saginaw aquifer.

One well in Neighborhood “E” has been instrumented, at 323 Seneca. The well is inferred to be cased into the Saginaw confining unit at 94 feet below grade, and with a total depth of 200 feet, is thought to extend through the Parma sandstone and into the Marshall sandstone. The water level in the well has ranged from 929 to 938 ft amsl, and about 5 feet of drawdown has been observed since April 2021 when JGS well PW-1 began operation (Figure C-3).

Modelling indicates that at an additional steady-state withdrawal of 1.36 MGD, an additional 10 to 15 feet of drawdown could potentially be observed in Neighborhood “E”. However, it appears that most (though not all) residences in this neighborhood have connected to municipal water, so the number of wells at risk cannot be reasonably estimated, but is expected to be low.

Neighborhood “F”

Neighborhood “F” consists of approximately the SE1/4 of Section 31 of Leoni Township, and the southern ½ of the NE1/4, located east of US-127 and directly east to northeast of the Neighborhood “B”, and approximately 5,000 to 6,500 feet east of the JGS supply well (Figure C-5). The private wells are clustered along Curtis Avenue and Watts Road.

Well records exist for 17 of approximately 70 residences (24%). Like Neighborhood “B”, the majority of the wells are cased or completed above the Saginaw confining unit.

- Three wells were completed in the overburden.
- Twelve wells are completed in the Saginaw sandstone aquifer, having an average depth of 105 feet and an average static water level of 32 feet.
- Two wells are completed in the P/B aquifer (average depth, 190 feet and average static water level, 46 feet). Based on the water well records, it is inferred that of the P/B wells are cased into the Saginaw confining unit and may be influenced by City of Jackson and JGS high-capacity withdrawals.

Additionally, three commercial/industrial wells in Neighborhood “F” appear to be completed in the Marshall sandstone. Two wells at the Maurer car wash (3500 Ann Arbor Road) are 246 feet deep and are unused, but accessible for monitoring. One of these wells at 3500 Ann Arbor Road was instrumented (Figure C-4). Additionally, MECA Associates (Michigan Extruded Aluminium) on Watts Rd. was contacted about instrumenting their deep well, but the well is no longer in service and has been sealed.

Modelling indicates that at an additional steady-state withdrawal of 1.36 MGD, an additional 5 to 10 feet of drawdown could potentially be observed in Neighborhood “F”. Extrapolating from the 2 of 17 wells identified as potentially sensitive to high-capacity withdrawals, to the approximately 70 wells in the neighborhood, there may be 6 to 8 wells at risk of experiencing interference, though the degree of interference will be less than in Neighborhoods “B” and “D”.

Summary

Table 1 summarizes the 133 well records reviewed to evaluate the geographic and aquifer distribution of private wells near JGS:

Table 1:
Number of Private Well Records in each Formation

Neighborhood	Overburden	Saginaw	Parma	Marshall	Total
A	0	4	1*	2*	7
B	2	25	11	0	38
C	0	4	6	0	10
D	0	1	17	0	18
E	6	6	28	0	40
F	3	12	2	3**	20
Total	11	52	65	5	133

* - Irrigation wells
** - Commercial/industrial wells

Extrapolating the well records available to the remainder of properties in the area (approximately 360), Table 2 estimates the number of wells in each neighborhood drilled to each aquifer:

Table 2:
Extrapolated Number of Residential Wells in each Formation

Neighborhood	Overburden	Saginaw	P/B cased above SCU	P/B cased into or below SCU	Comments
A	0	12	0	0	Estimating 1/3 of records available
B	6	75	16	17	Estimating 1/3 of records available
C	0	0	1	1	Assume only one well exists
D	0	2	8	26	Estimating 1/2 of records available
E	18	18	24	60	Estimating 1/3 of records available
F	12	48	0	8	Estimating 1/4 of records available
Total	36	155	49	112	

SCU – Saginaw Confining Unit
* - the table excludes known irrigation and industrial/commercial wells in Marshall formation.

Based on this extrapolation:

- Approximately 191 of 355 wells (54%) of wells in these six neighborhoods may be completed in the overburden and Saginaw aquifer and therefore are unlikely to be measurably affected by the new withdrawal.
- Approximately 161 wells completed may be in the P/B aquifer. However, more than one-half (84) of these are located in Neighborhood “E”, located between 3,500 and 6,300 feet away from the current supply well, and where most residences have reportedly been connected to municipal water. The well at 323 Seneca (200 feet deep) monitors the lower Parma sandstone aquifer in Neighborhood “E”, at which approximately 5 feet of influence has been observed from the new JGS well.
- Approximately 52 wells may be located in the P/B aquifer, and cased into the Saginaw confining unit, in Neighborhoods “B”, “D”, and “F”. The P/B aquifer is monitored at 3141 Sparks (157 feet); and 429 S Dettman (181 feet). Based on an additional steady-state withdrawal of 1.36 MGD, including a reduction in City of Jackson withdrawals, the model predicts that 10 to 15 feet of drawdown is likely to be observed in Parma aquifer wells in this area that are cased into the Saginaw confining unit.

WELL CONFLICT POTENTIAL

A well conflict occurs when a new water withdrawal decreases the height of the water column above the pump intake of a nearby well, such that the pump entrains air when activated. When capturing air through the intake, the pump fails to deliver sufficient water when activated by the pressure tank, potentially resulting in damage to both the tank and pump.

Ultimately, a well conflict is typically the last of multiple, compounding factors such as:

- The pump was set too shallow upon installation (i.e., the pump is suspended on insufficient drop pipe)
- The pump is too strong for the well, drawing the water level down too fast
- Clogging caused by lime scaling, or insufficient development, has over time physically degraded how quickly water can enter the well
- The static water level above the pump has decreased since installation (i.e., seasonal drought, or one or more high-capacity withdrawals)

A new or expanded use such as filling a pool, or irrigating lawns and gardens, could potentially stress the well to the point of failure. For this reason, aquifer drawdown generated by a new high-capacity withdrawal is not likely to cause every well in an area to fail; but select wells will be more susceptible that others due to their construction, age, and usage.

The Water Well Records for wells drilled to the Parma were reviewed again to evaluate pump settings relative to the water table. Only a few records contained the necessary information to calculate the water column height, but most wells have 20 to 30 feet of water above the pump:

- Neighborhood “A” – no Parma wells
- Neighborhood “B” – 7 Parma wells, average 22 feet of water above pump
- Neighborhood “D” – 8 Parma wells, average 31 feet of water above pump
- Neighborhood “E” – 9 Parma wells, average 23 feet of water above pump

- Neighborhood “F” – 1 Parma well, 23 feet of water above pump

The private wells most likely to be impacted will be located in Neighborhoods “B” or “D”, where well records report that most wells have between 20 and 25 feet of water above the pump.

MITIGATION STRATEGY

Most private wells with 20 to 25 feet of water above the pump should have sufficient submergence to continue operating under the new groundwater conditions associated with this proposed withdrawal. However, by definition, about one-half of wells will have less water than average above the pump intake, and well records could not be located for two-thirds of nearby wells, so the depth of submergence cannot be known. It is therefore expected that there will be some private wells at which even minor drawdown may result in a well conflict.

It is also expected that within the next few years that some well pumps, installed when these neighborhoods became developed in the 1970’s and 1980’s, will fail for reasons other than interference by the JGS withdrawal. Old wells and pumps are prone to failure of the electric supply; mechanical issues such as worn pump impellers and rusted pipes; and clogging caused by bacteria, scaling, or sediment. CEC is committed to assisting the local community in diagnosing well issues and will be responsive to the Jackson County Health Department (JCHD).

Routing of Well Complaints

Private property owners concerned that their private well is entraining air are directed to contact either their township administration (Leoni, Blackman, or Summit), and/or the Jackson County Health Department (JCHD). The JCHD in turn will contact CEC Community Affairs department. Should CEC be contacted directly by a resident, the CEC Community Affairs department will inform JCHD of the referral, JCHD will be responsible for tracking addresses of any incoming well complaints to evaluate if a geographic pattern exists, and to ensure that complaints are adequately addressed.

Evaluation and Mitigation of Well Complaints

Complaints received by JCHD will be forwarded to the CEC Community Affairs department for further action. CEC will retain one local well driller, one pump installer, and an environmental consultant to investigate and address any legitimate concerns that the installation and operation of JGS wells are having an impact on nearby wells. A contractor will be dispatched to the private well within 2 business days of receiving written notification of an alleged issue. The contractor will establish the nature and cause of the issue and verify if the issue is reasonably related to CEC’s well installation or operation. JCHD and CEC will be informed of the contractor’s findings, in writing, and will participate in discussions regarding CEC’s responsibilities and proposed mitigation. If JCHD and CEC agree that CEC is likely responsible, the appropriate well mitigation or hook-up to municipal water will be undertaken at CEC’s expense.

CEC will continue to monitor hydrologic conditions and further study the effects of the proposed withdrawal on aquifer water levels. If the well complaint is not consistent with regional observations, CEC will discuss findings with JCHD. If JCHD agrees that the well complaint is unlikely to be related to CEC, the property owner will be responsible for their well’s repairs, but CEC will not seek reimbursement for evaluating the well.

Potential Mitigation Actions

The most likely mitigating remedy for any interfered well will be to lower the submersible pump. Any impacted well completed below the Saginaw confining unit should have at least 60 feet or more of water remaining below the pump. With water levels in Neighborhoods “B” and “D” approximately 50 to 60 feet below grade in wells

completed below the Saginaw confining unit, pumps are typically set approximately 80 feet below grade. Typical well depths in this area, for wells cased into the Saginaw confining unit, extend to 150 to 200 feet below grade.

If an interfered well is determined to not adhere to code, or a situation exists where the pump cannot be lowered, such as the well is located in the residence's basement, CEC will be responsive to JCHD with respect to identifying an appropriate mitigation solution, which could potentially include replacing the entire well, or connecting the residence to municipal water.

Funding to Address Well Complaints

If any complaints are received, the time and expense to address the complaint would be categorized by CEC as an "emergent issue," the terminology required for rate case documentation. CEC reserves budget for emergent issues through multiple funding mechanisms. The JGS water supply project has a small contingency for emergent issues, and projects which are tracking below budget can also be used to fund emergent issues. Additionally, JGS maintains a small pool of money with which to address emergent issues.

Long-Term Monitoring

As discussed, CEC formed agreements with 11 private well owners to install datalogging transducers to evaluate local groundwater conditions. The first wells were instrumented in March 2021, and the last one (Maurer's Car Wash, 3500 Ann Arbor Road) was instrumented in July 2021 before the aquifer test. The agreements are voluntary and may be terminated at any time by the resident.

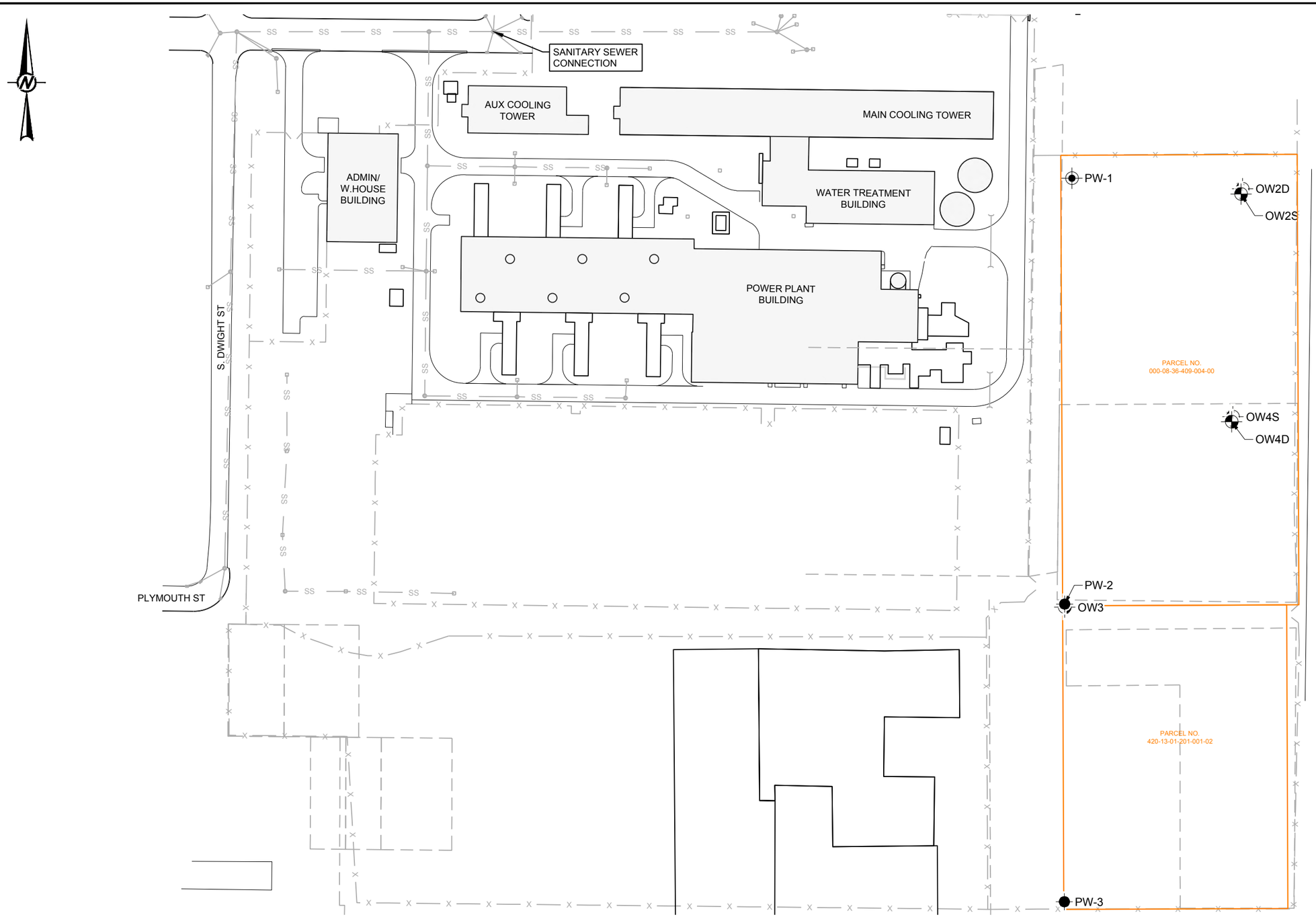
The five observation wells installed on the JGS property are instrumented and recording water levels. CEC will continue to monitor water levels in these wells for a minimum of two years to further assess the local hydrogeology of the site and effects of the withdrawal, including documenting the absence of impact to the wetland.

As noted, CEC has operated well PW-1 since April 2021 at an average rate of 1.4 MGD. No well complaints have been received to date.

SUMMARY

The JGS supply well, PW-1, was designed to minimize hydraulic effects on overlying units and to minimize the impacts on private wells completed in the P/B aquifer. The supply well is cased through the Parma sandstone and into the Bayport limestone and/or Michigan formation, drawing water directly from the Marshall sandstone. However, because of local thinness or absence of the Michigan formation, it is expected that withdrawals from the Marshall will affect water levels in the overlying P/B aquifer.

The number of nearby private wells that may be impacted by the proposed withdrawal is expected to be low, but due to the incompleteness and partial availability of local water well records, the number cannot be accurately known. CEC is committed to evaluating and mitigating any pump failures related to its proposed withdrawal. CEC will coordinate with JCHD to track and respond to well complaints and ensure that complaints are resolved. CEC has committed to reserve "emergent issue" funds to evaluate and if necessary, lower submersible pumps.



LEGEND

PW	PRODUCTION WELL
PW	PROPOSED PRODUCTION WELL
OW	OBSERVATION WELL

REFERENCE

BASE MAP TAKEN FROM CONSUMERS ENERGY ALTA/ACSM SURVEY, DATED 06-18-2014; DRAWING NO. SG-21492.

CLIENT
CONSUMERS ENERGY

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-29
DESIGNED	JH
PREPARED	DJC
REVIEWED	
APPROVED	

TITLE
PRODUCTION WELL AND OBSERVATION WELL LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
19131361	19131361A001.dwg	0	C-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in
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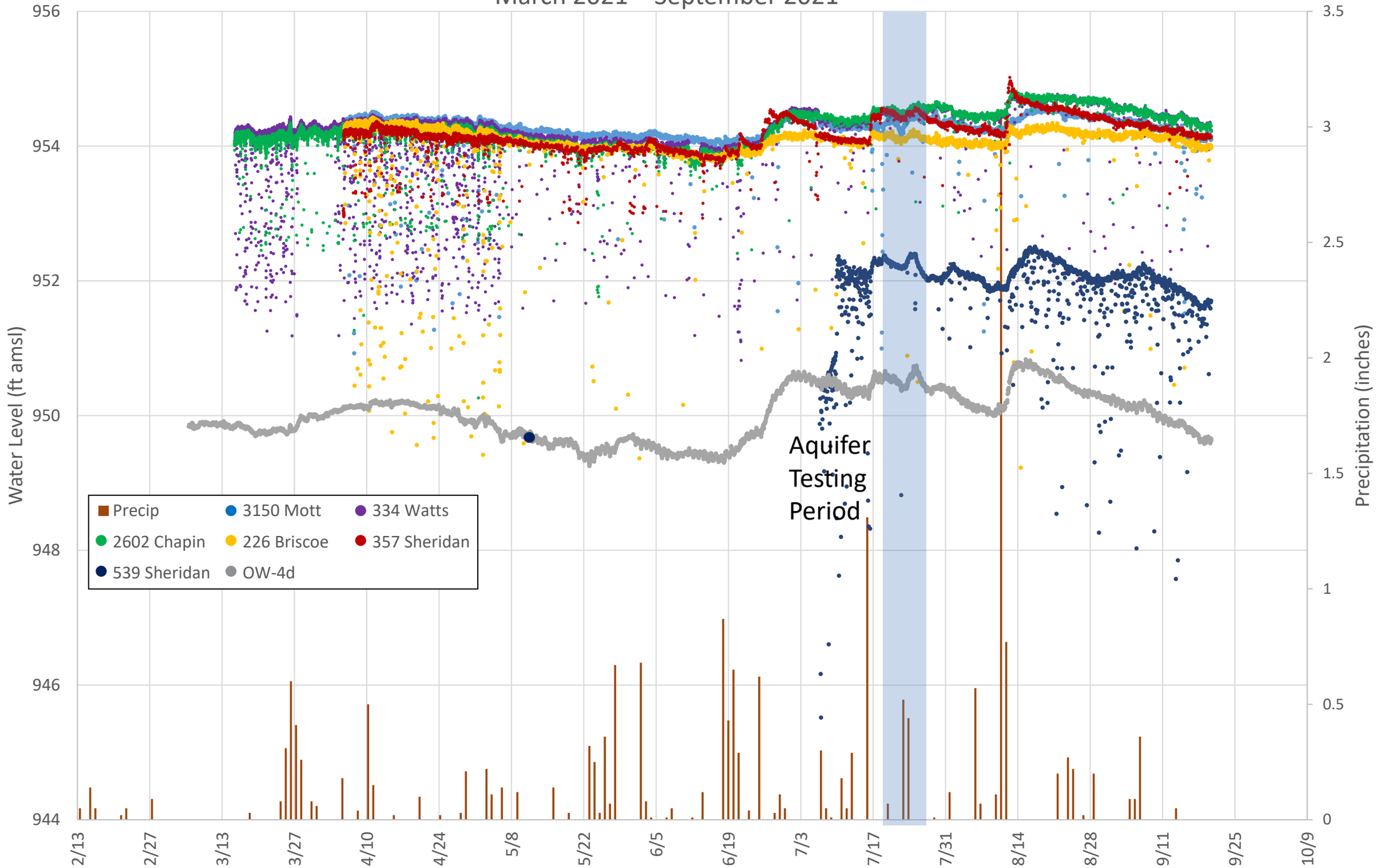
Saginaw and Overburden Aquifer Wells
March 2021 – September 2021



CLIENT

CONSULTANT
GOLDER

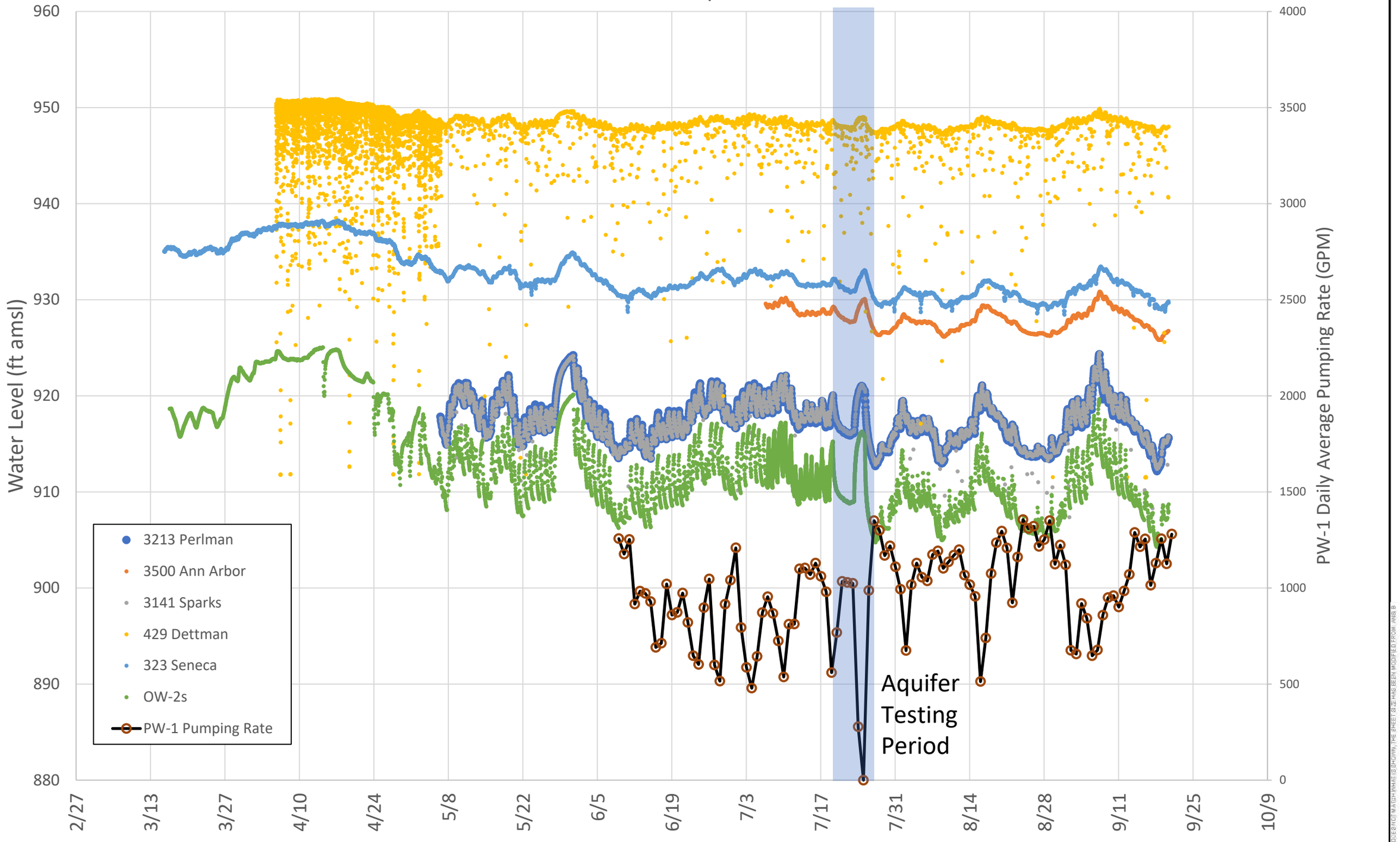
PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
WATER LEVELS
SAGINAW AQUIFER AND OVERBURDEN WELLS
MARCH - SEPTEMBER 2021

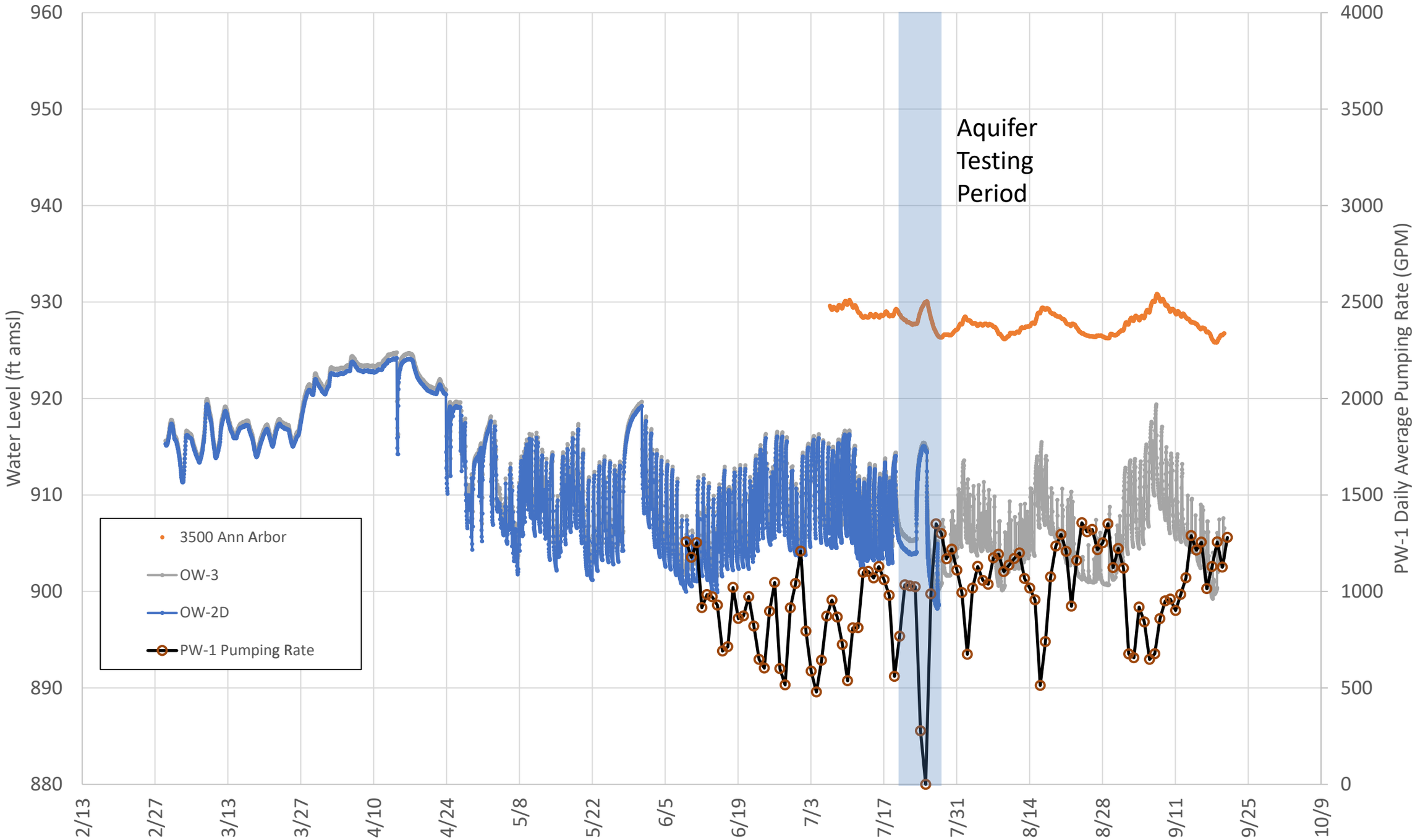
PROJECT NO. 19131361 | CONTROL | REV. | FIGURE C-2

Parma-Bayport Aquifer Wells
March 2021 – September 2021



CLIENT		PROJECT	JACKSON GENERATING STATION WATER WITHDRAWAL PERMIT APPLICATION
CONSULTANT	GOLDER	TITLE	WATER LEVELS PARMA AQUIFER WELLS MARCH - SEPTEMBER 2021
YYYY-MM-DD	2021-11-30		
PREPARED	JCH		
DESIGNED	JCH		
REVIEWED	AO		
APPROVED	MW		
PROJECT NO.	19131361	CONTROL	REV. FIGURE C-3

Marshall Aquifer Wells
March 2021 – September 2021



CLIENT

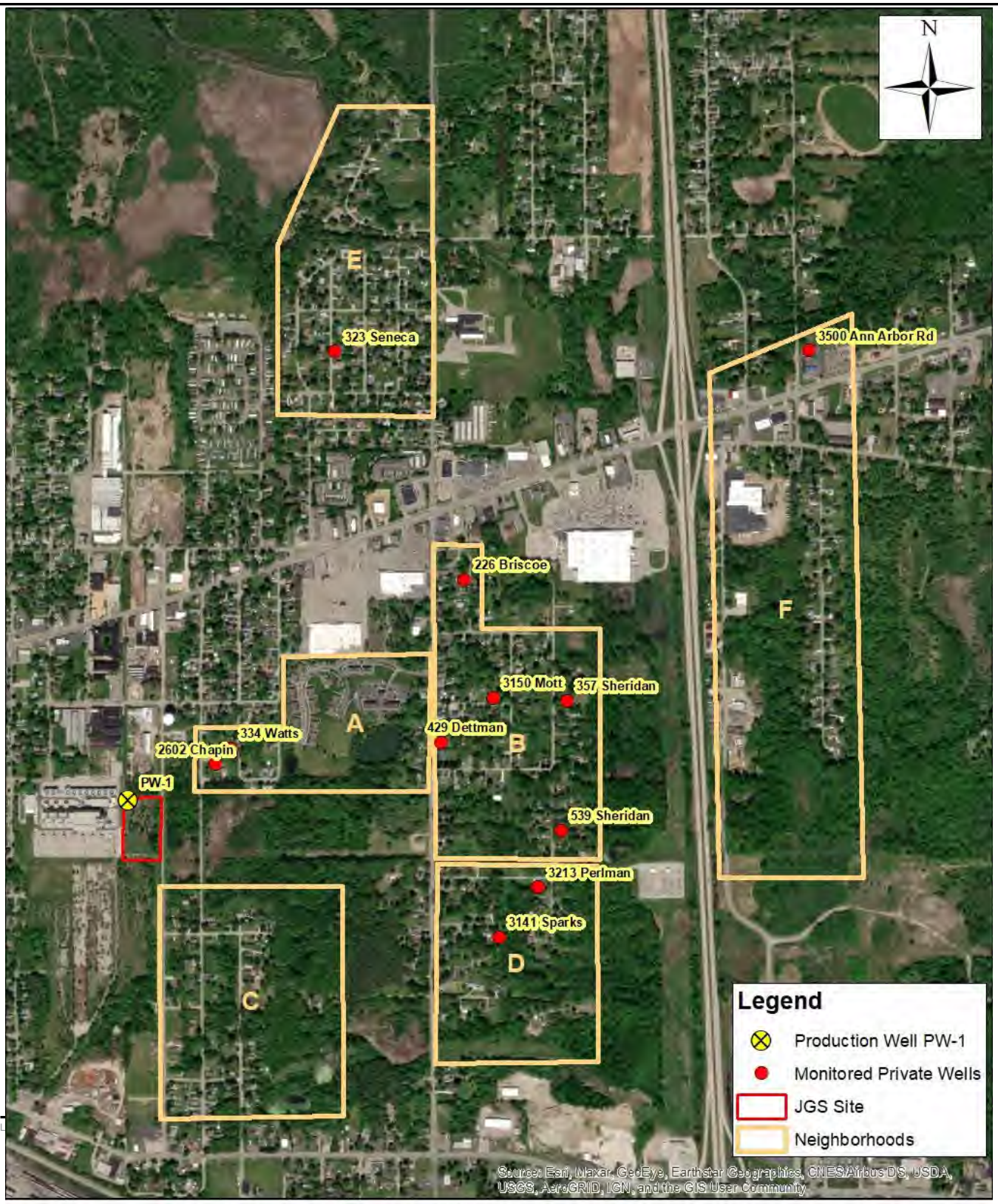
CONSULTANT
GOLDER

PROJECT
JACKSON GENERATING STATION
WATER WITHDRAWAL PERMIT APPLICATION

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGNED	JCH
REVIEWED	AO
APPROVED	MW

TITLE
WATER LEVELS
MARSHALL AQUIFER WELLS
MARCH - SEPTEMBER 2021

PROJECT NO.	CONTROL	REV.	FIGURE
19131361			C-4



0 1,000 2,000 Feet

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CLIENT
CONSUMERS ENERGY COMPANY

PROJECT
JACKSON GENERATING STATION
PART 327 PERMIT APPLICATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-30
PREPARED	JCH
DESIGN	JCH
REVIEW	AO
APPROVED	MW

TITLE
PRIVATE WELL NETWORK

PROJECT No.	PHASE	Rev.	FIGURE
19131361	**----**	**A**	**C-5**

FILE PATH: XXX

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A

EGLE

Department of Environment, Great Lakes, and Energy

WATER WITHDRAWAL PERMIT

Issued under Part 327, Great Lakes Preservation
Natural Resources and Environmental Protection Act, 1994 PA 451, as amended

In accordance with Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), authority is hereby given to withdraw water from the waters of the State of Michigan as described herein. This permit is issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in reliance upon information supplied by the permittee in support of the permit application.

PERMIT NUMBER: **2022-001** DATE ISSUED: xxxxx

Permittee Name and Address: Rachel Proctor
Consumers Energy Company
1945 West Parnall Road
Jackson, Michigan 49201

Location of Water Withdrawal
County: Jackson County
Town, Range, and Section: T2S, R1W, Section 36 and T3S, R1W, Section 1
Project Identification: Jackson Generating Station
Project Boundary/Description: 2219 Chapin Street, Jackson, MI, 49203

The activity authorized by this permit is subject to the following:

Section A. Authorizations and Approval Conditions

1. Water Withdrawal is restricted to the following sources, locations, rates, and purposes:

Source	Latitude and Longitude approx.	Withdrawal Rate maximum	Purpose of Use
Groundwater	42.24896°, -84.3747°	5 million gallons per day	Electric power generation

2. Return Flow Discharge is restricted to the following locations:

Receiving Water Body	Latitude and Longitude approx.	Discharge Rate
Grand River via Jackson Wastewater Treatment Plant	42.28162°, -84.40936°	0.833 million gallons per day

3. Approval Conditions

a. This permit requires the permittee to maintain compliance with all applicable local, state, and federal laws including, but not limited to, obtaining, and remaining compliant with all required permits.

b. The permittee must remain in compliance with the environmentally sound and economically feasible water conservation measures applicable to electric power generation.

c. If the withdrawal permitted herein adversely impacts other water supply wells the permittee is required to make immediate corrective actions as necessary to restore water quality and/or quantity.

d. The permittee must contact EGLE at 517-599-3792 or wateruseprogram@michigan.gov if there are revisions to the permitted withdrawal. Revisions that exceed the scope of the original review will require a new public notice.

Section B. Reporting and Record Keeping

1. Environmental Impacts

The permittee is required to immediately report to EGLE at 517-599-3792 or to wateruseprogram@michigan.gov if an adverse resource impact (ARI), as defined in Subsection 32701(1)(a) of Part 327 of the NREPA occurs because of the water withdrawal authorized by this permit.

2. Public and Private Rights Impacts

The permittee is required to immediately report to EGLE at 517-599-3792 or to wateruseprogram@michigan.gov if any interference with public or private rights occurs because of the water withdrawal authorized by this permit including but not limited to interference with water supply wells, or lowering water levels in lakes, ponds, rivers, streams, or wetlands.

3. Annual Water Use Report

The permittee is required to submit an annual water use report and payment for the water use reporting fee, if applicable, to the State of Michigan by April 1 of each year. A water use reporting notice and water use reporting fee invoice will be sent to the permittee by mail each year in advance of the April 1 deadline.

Section C. Liability

1. Noncompliance

Commencing the water withdrawal authorized herein confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit. Noncompliance with these terms and conditions, and/or the initiation of other regulated activities not specifically authorized by this permit, shall be cause for the modification, suspension, or revocation of this permit, in whole or in part. Further, EGLE may initiate civil proceedings to correct deficiencies, protect natural resource values, and secure compliance with law.

2. Limitations

This permit does not authorize causing an ARI as defined in Subsection 32701(1)(a) of Part 327 of the NREPA.

This permit does not convey property rights in water, or other real or personal property,

authorize any injury to private property or invasion of public or private rights, or waive the necessity of obtaining any other applicable federal, state, or local permit or approval.

3. Indemnification

The permittee shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, employees, agents, and representatives for any and all claims or causes of action arising from acts or omissions of the permittee, or employees, agents, or representatives of the permittee, undertaken in connection with this permit. This permit shall not be construed as an indemnity by the State of Michigan for the benefit of the permittee or any other person.

Section D. Contested Case Procedure

Any person who is aggrieved by this permit may request a contested case hearing pursuant to the Michigan Administrative Procedures Act by filing a sworn petition with the Michigan Administrative Hearing System within the Michigan Department of Licensing and Regulatory Affairs (LARA), c/o EGLE, that specifies the conditions of the permit which are being challenged and sets forth the grounds for the challenge. LARA may reject any petition filed more than 60 days after permit issuance as being untimely.

Section E. Permit Execution

This permit shall become effective on the date of EGLE's representative's signature.

Liesl Eichler Clark, Director
Michigan Department of Environment, Great Lakes, and Energy

Signed By:

_____ _____
Christine Alexander, Manager DATE
Permits Section
Water Resources Division